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American Congress of Physical Medicine and Rehabilitation

32nd Annual

Scientific and Clinical Session

and

Instruction Seminar

SEPTEMBER 6-11, 1954

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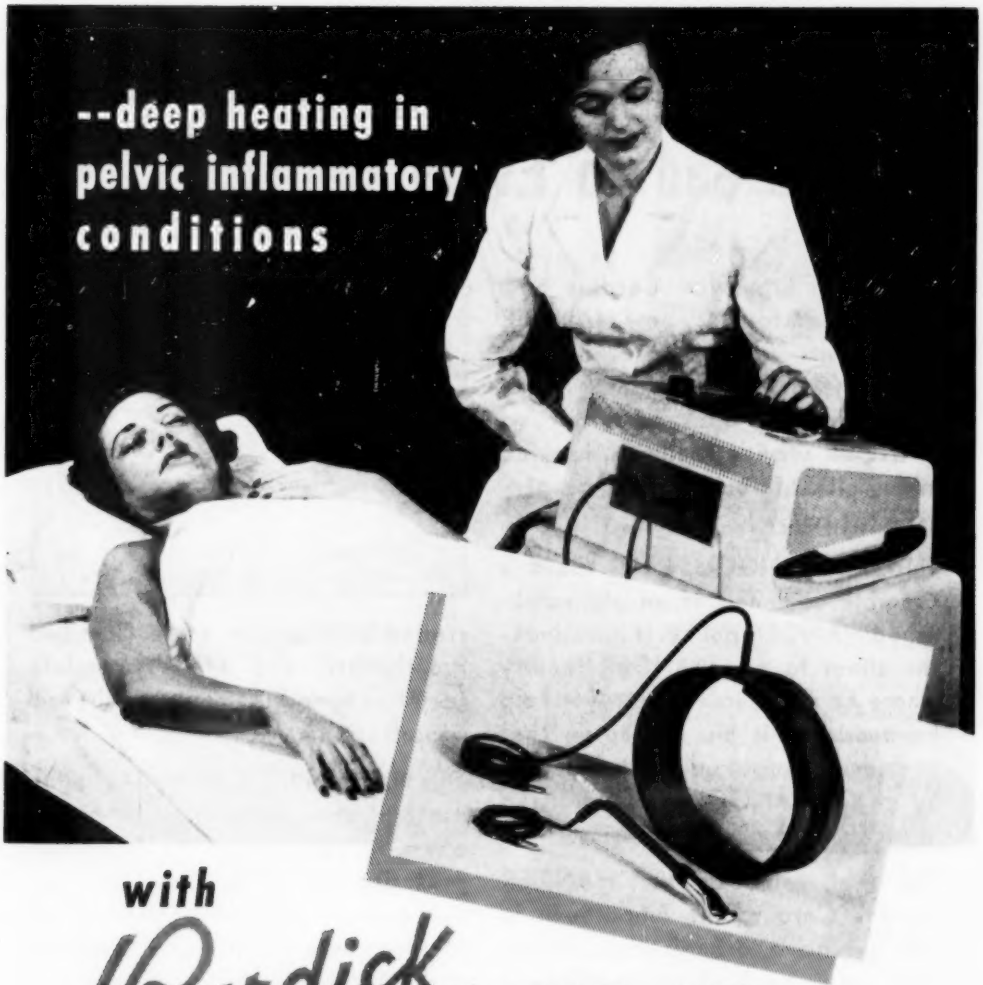

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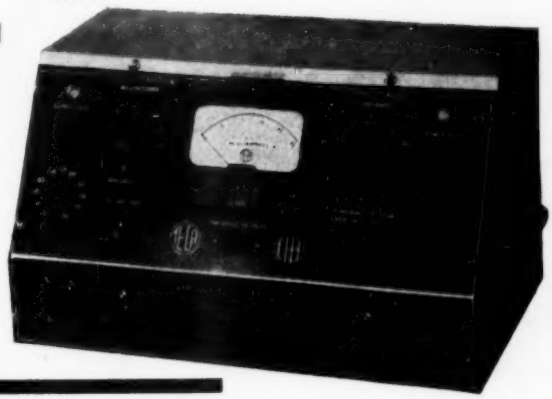

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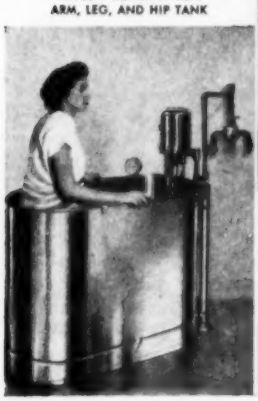

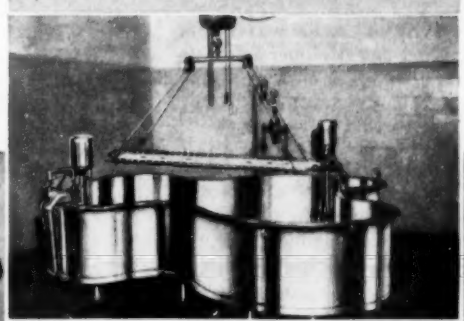

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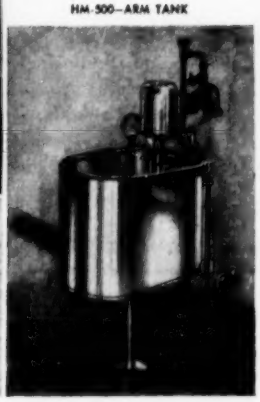

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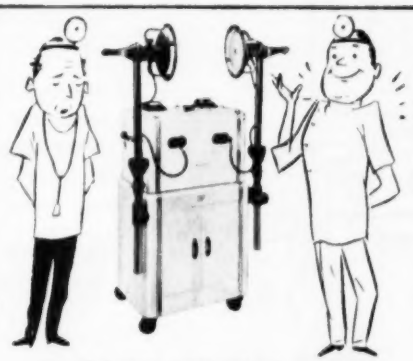

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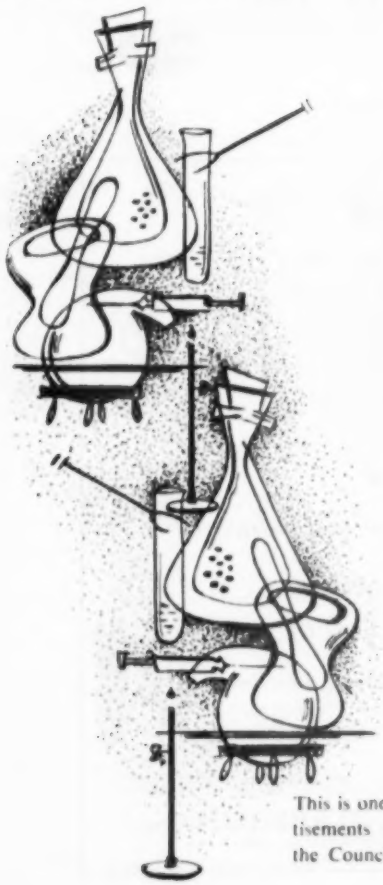

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(Formerly Archives of Physical Medicine)

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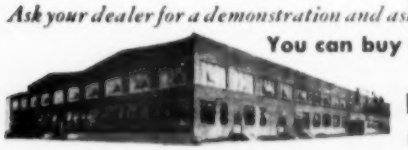

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Studies On Anterior Poliomyelitis Patients With Respiratory Paralysis

O. Leonard Huddleston, M.D., Ph.D.[1]
David Rubin, M.D., Ph.D.[2]
Richard W. Moore, M.D.[3]
Rene Cailliet, M.D.[4]
and
Herman Kabat, M.D., Ph.D.[5]

Introduction

The purpose of this paper is to present our concept of the physical treatment of anterior poliomyelitis patients with respiratory weakness or paralysis and to report clinical observations made on some of the patients we have treated. The apparatus and equipment used, together with the technique of application to the treatment of respiratory muscle paralysis, have been adequately described by Bower and his associates[1,2]. The theory and practice of treating the chronic respirator patient, as carried out at the Los Angeles County General Hospital and at the Rancho Los Amigos, have been presented in a mimeographed pamphlet by Austin, Dail, and Rubin[3]. Many of the testing and treatment procedures advocated by the authors of this pamphlet are employed at the Kabat-Kaiser Institute for Neuromuscular Rehabilitation in Santa Monica.

Three additional phases of treatment are presented in this paper which have not been extensively described in the management of respirator poliomyelitis patients. They are: (1) the early and extended use of manual resistive exercises; (2) the utilization of reinforcement techniques to facilitate the motor response of the muscles of respiration, and (3) early and prolonged mobilization therapy.

The largest proportion of our patients with respiratory involvement are classified as "stand-by" respirator patients.*

*A stand-by respirator patient as used herein is one who, in the acute phase of the disease, develops such a degree of respiratory muscle paralysis as to be considered a possible candidate for the respirator, but continues to maintain a sufficient ventilatory exchange to avoid the need for such aid.

Observations on this group are not included in this report, principally because the rate of recovery of respiratory function has been so rapid that their inclusion would seem unnecessary. The clinical observations to be reported will be limited, therefore, to the most severely involved post-respirator, part-time respirator, and full-time respirator patients.

Resume' of Treatment Program

Evaluation Procedures: Initial and periodic evaluation of the physical status of the patient is made, either by accurately measuring or by roughly estimating the degree of abnormality of: (1) pulmonary ventilation; (2) the amount of mucus; (3) the amount and extent of muscle "spasm"; (4) the extent and degree of muscle paralysis; (5) the general appearance of the patient and the general status of function of the thoracic and abdominal viscera; (6) the degree of fatigue and general debility; (7) the type and extent of emotional disturbance (apprehension, fear, frustration, anxiety, irritability and excitability), and (8) signs of hypoxia, encephalitis, and bulbar or cerebellar involvement.

In the early stages of the illness, repeated measurements of the tidal air and vital capacity are useful guides for regulating the pressure adjustments of

Read at the Thirtieth Annual Session of the American Congress of Physical Medicine, New York, N. Y., August 26, 1952.

1. Resident Medical Director of Kabat-Kaiser Institute for Neuromuscular Rehabilitation, Santa Monica, California, and Clinical Professor of Physical Medicine, University of Southern California School of Medicine, Los Angeles.
2. Staff Physician, Kabat-Kaiser Institute for Neuromuscular Rehabilitation, Santa Monica, California, and Instructor in Physical Medicine, University of Southern California School of Medicine, Los Angeles
3. Assistant Resident Medical Director, Kabat-Kaiser Institute for Neuromuscular Rehabilitation, Santa Monica, California.
4. Staff Physician, Kabat-Kaiser Institute for Neuromuscular Rehabilitation, Santa Monica, California, and Director, Department of Physical Medicine, Permanente Medical Center; Instructor in Physical Medicine, University of Southern California School of Medicine, Los Angeles.
5. Medical Director, Kabat-Kaiser Institute for Neuromuscular Rehabilitation, Vallejo, California.

Fig. 1—Use of the Bennett Respiratory Ventilation Meter is illustrated. This type of spirometer consists of a facial mask, connecting tube, and a sensitive air or gas meter. This type of spirometer operates on the inspiratory phase of respiration.

the respirator (negative and positive intra-tank pressure and the positive intra-pulmonic pressure when intra-tracheal or mask positive pressure breathing is employed). Later the ventilation tests are useful to determine the rate of return of respiratory function and to provide quantitative data which enables the physiatrist to prescribe safely the amount of spontaneous breathing without respirator assistance. The Bennett Respiratory Ventilation Meter is used to quantitate the ventilation tests. Such quantitative respiratory data greatly assist the physiatrist in making a clinical evaluation of the patient.

Positioning: Meticulous attention to positioning must be observed at all times for patients with respiratory muscle paralysis. Proper alignment of the trunk and extremities of the respirator patient has been accomplished best by the use of the following equipment: (1) a small head pillow; (2) a Bishop Air Mattress; (3) an adjustable foot board; (4) sand bags, and (5) a soft sponge rubber hand roll, traction mittens or traction gloves (fig. 4).

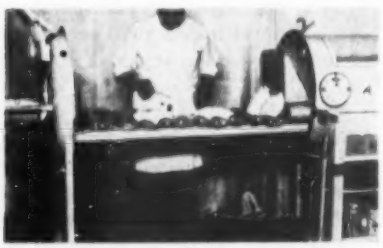

Fig. 2—Tank-type respirator and positive pressure breathing equipment, together with bed accessories for proper positioning of patient: (A) respirator; (B) positive pressure equipment; (C) head pillow and head rest; (D) Bishop Air Mattress; (E) sand bags; (F) footboard, and (G) mirror.

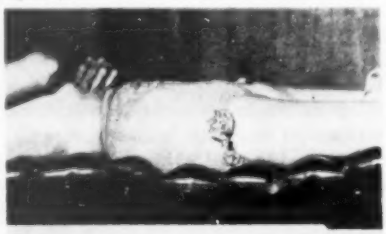

Fig. 3—Bishop Air Mattress which provides contour form-fitting support for the various curvatures of the posterior aspect of the body.

The air mattress, in addition to supplying a soft, uniform pressure support devoid of pressure point contacts, automatically adapts itself to the contour of the body (fig. 3). It will be noted that the upper surface of the mattress cushions the posterior convex curve of the thorax, the anterior concave curve of the lumbar region, the posterior convex curve of the sacrum and buttocks, the anterior concavity of the popliteal area, together with the posterior convex curve of the calf muscles and the anterior concavity of the heel cord area. Adequate,

Fig. 4—Traction mittens which provide warmth for the hands, traction for the extensor muscles and soft tissues of the thumb and fingers, and positioning of the hand with semi-flexion of the fingers, adduction and opponens positioning of the thumb. The sponge rubber roll provides the position and the elastic straps provide the traction.

uniform pressure is also provided for the heels, which fit into a mild depression of the mattress. This construction provides not only comfort and contour support of uniform pressure, but minimizes the danger of the development of decubitus ulcers.

An illustration of the traction mittens is shown in figure 4. They provide warmth for the hands, adjustable traction for the fingers and thumb, and permit the use of sponge rubber rolls of various sizes to position properly the fingers and thumbs. Traction mittens or gloves are worn by patients in whom contractures and deformities of the wrists and hands have developed. The duration of the application of the traction varies with the severity of the contractures and the tolerance of the patient. The prevention of contractures and deformities of the hands can usually be accomplished by proper positioning of the wrist, hand, and thumb by means of a bandage and a sponge rubber hand roll. However, a few patients may develop contractures, stiff joints, and varying degrees of deformity of the forearms and hands in spite of the preventive measures of proper traction, proper positioning, and repeated mobilization.

Treatment of Intercostal Spasm: When there is evidence of limitation of excursion of the chest wall because of "spasm" of the intercostal muscles, various procedures are employed to increase the range of movement of the thorax in its antero-posterior, transverse, and longitudinal diameters.

Hot Packs: Continuous or rapidly repeated Kenny-type lay-on packs are applied to the chest and upper abdomen for several hours with varying intervals of rest, depending upon the severity of the respiratory involvement and the limitation of motion of the thorax. In addition to chest packs, more extensive intermittent packing may be used to relieve the muscle soreness and spasm existing in the remainder of the trunk and extremities. Half packs for the upper extremities and trunk may be employed alternately with half packs to the lower extremities, and changed often enough to be equivalent to two full packs daily.

Forced Breathing with Respirator Equipment: Tolerance intra-tank negative and positive pressure may be applied periodically for short periods of time to increase the range of excursion of the chest wall. At times this type of mobilization of the chest wall may be combined with an increased intra-pulmonic pressure supplied by the intratracheal or mask positive pressure equipment of the respirator [Drinker-Collins or Emerson] (fig. 2). The duration of the treatment with either increased positive and negative intra-tank pressure or the combined intra-tank and positive intra-pulmonic pressures is usually five minutes or less. When such treatments are provided the patient is encouraged to make maximal inspiratory and expiratory efforts synchronized with the respirator. A similar type of chest expansion may be provided by positive pressure insufflations alone with the patient remaining on the tray of the respirator or treated either in bed or on a treatment table. Either the positive pressure attachment of the tank respirator or the Bennett flow-sensitive positive-pressure apparatus (fig. 5) may be used, though the latter procedure is carried out only when the patient has obtained sufficient recovery to aerate his lungs spontaneously for varying periods of time without

Fig. 5—Proper positioning of the patient and the Bennett flow-sensitive positive pressure breathing apparatus. The positive pressure breathing apparatus supplied by the respirator is also shown in this illustration. This type of arrangement demonstrates the increased facilities for providing nursing care and treating the patient: (A) respirator patient; (B) air mattress covered by sheet and mattress pad; (C) sand bags; (D) Bennett flow-sensitive positive pressure breathing apparatus, and (E) positive pressure breathing attachment for the Drinker-Collins respirator.

the aid of the respirator.

Manual Mobilization Therapy: The early and prolonged utilization of mobilization therapy is important in increasing the mobility and flexibility of the soft tissues of the neck, trunk, and extremities, and in maintaining normal range of motion of the joints, particularly those of the neck and trunk. Passive movement, combined with varying degrees of manual traction, is carried out at least once a day by the physiatrist. The joints are moved through the range of motion in straight flexion, extension, lateral flexion to the right and to the left, and diagonally from flexion left to extension right, and from flexion right to extension left. The range of motion for the joints of the neck is achieved by moving the long and short neck flexors and extensors in a similar manner as often as indicated. Mobilization of the shoulders, elbows, wrists, fingers and thumbs on each side is carried out while the patient is still on negative pressure within the respirator. Joint mobilization is accomplished by employing the manipulative techniques described by Mennell.[4] This type of treatment is started as early as commensurate with the physical status and tolerance of the patient. Mobilization of the intervertebral joints, as well as the costovertebral and costosternal joints is accomplished by unilateral elevation and rotation of different sections of the thoracic, lumbar, and pelvic regions of the trunk. Likewise the costal joints connecting the ribs with the vertebrae and sternum are mobilized by compressing the chest from side to side and from front to back. When the patient is confined to the respirator and is dependent upon the negative intratank pressure changes for survival, mobilization is carried out through the portholes and is usually confined to treatment on first one side of the body and then the other. When recovery is sufficient to warrant work with the patient on positive intra-pulmonic pressure breathing alone, the mobilization manœuvers may be continued unilaterally or may be performed bilaterally.

Forced breathing techniques may be used with maximal voluntary efforts before and following the mobilization manœuvers, but not during the mobilizing treatment, for it is essential that the patient remain as completely passive and relaxed as possible. Mobilization of the joints of the shoulders, hands, and trunk is of paramount importance to prevent the development of deformities and disabilities resulting from contractures and fibrosis.

Early mobilization of the joints of the trunk not only improves the respiratory efficiency of the patient but prevents the complications and sequelae of inactivity which ultimately develop into disabilities causing limitation of joint motion. Mobilization of the soft tissues, such as the skin, subcutaneous tissue and connective tissue forming the fascia, intermuscular septa, ligaments, tendons and capsular tissues, insures flexibility, distensability, and elasticity that minimizes the constant tendency to develop fibrosis and pathological contractures. In addition, mobilization therapy counteracts a diminished blood supply and the poor nutrition of the soft tissues and structural elements (bone and cartilage) which characteristically accompany prolonged inactivity resulting from either paralysis or spasm. As soon as it is possible for the patient to be removed from the respirator completely for short periods of time the mobilization therapy is done either with the patient in bed or on a treatment table. Unilateral and bilateral

mobilization maneuvers are employed. Ideally these treatments are given daily, with a minimum of two or three times weekly. When necessary, ventilation assistance may be provided by a Bennett flow-sensitive positive-pressure breathing unit before and after treatment. Appropriate gas mixtures of various kinds [room air, air and oxygen or helium and oxygen] (see fig. 5) may be administered with this equipment.

Manual Resistive Exercises: Since pulmonary ventilation is dependent largely upon the contractile power of the muscles of the neck, chest, and abdomen, it is important that maximal return of motor power and control of these muscles be accomplished as rapidly as possible. The word "motorvation," as applied to the muscles of respiration, including the accessory muscles, may be used to express the number and frequency of the motor impulses delivered by the spinal cord through the peripheral nerves and the ability of the contractile elements to respond to the nerve impulses. The number of motor units involved in any reflex or voluntary effort is determined by the integrative action of the central nervous system.

A maximal voluntary response results when the patient makes a maximal voluntary effort against a resistive force which may be more than sufficient to permit any motion, or just sufficient to permit a desired range and rate of motion of the moving parts, thus providing either isometric or isotonic contractions of muscles respectively. The utilization of maximal isometric and isotonic contraction of muscles insures maximum recruitment of motor neurons and maximal frequency of motor discharges; repetitive isometric and isotonic contraction of paretic muscles permanently enlists an additional number of active motor units in the "motorvation" pattern. The procurement of additional active motor units in functional motion patterns constitutes one of the basic principals of neuromuscular re-education.

Repeated contractions against maximal resistance likewise develops muscle hypertrophy and additional muscle power. Manual resistive exercises, therefore, are provided one or more times daily while the patient is in the respirator and more vigorously when the patient may be treated with positive pressure breathing either on the respirator tray or on the bed or treatment table. The resistive exercises are performed by the neck muscles (long and short neck flexors and extensors, lateral flexors, and rotators). Both isometric and isotonic muscular contractions are utilized in straight and diagonal motion patterns. The technique of carrying out the manual resistive exercises for the neck muscles may be briefly described. The exercises are performed as alternate isotonic and isometric resistive contraction of the neck muscles using the following technique and motion patterns:

A. NECK FLEXION EXERCISES:

Contraction Hold Technique

1. The patient's head is held in one hand of the operator (physiatrist or physical therapist) and the other hand is placed on the patient's forehead. The starting position for the flexion exercise may be that of the neutral position 180° or the extension position 235° (360° system), or 0° neutral position to 45° extension (180° system).
2. The patient is asked to raise the head ("pull contraction") while the operator provides resistance to the contraction of the neck muscles throughout the range of flexion by counteracting the head motion with his hand on the patient's forehead. The amount of resistance offered is the greatest amount against which the patient can move his head. This provides a maximal isotonic contraction of the neck flexors.
3. When the patient's head has moved through full flexion, or his maximal flexion range, he is asked to maintain it in the flexed position ("hold contraction") and the operator applies a manual force greater than that supplied by the neck flexors and moves the head

through a portion of the range while the patient still exerts maximal effort to sustain the contraction of the flexor muscles. This provides a maximal isometric contraction for the anterior neck muscles.

B. EXTENSION, LATERAL FLEXION, AND NECK ROTATION EXERCISES:

Contraction Hold Technique

The technique employed in performing the isotonic and isometric contraction of the posterior and lateral neck muscles may be accomplished in essentially the same manner as for the neck flexors, namely, by using one hand for support and guidance and the other hand for resistance and guidance.

Slow Reversal Technique

When the flexion and extension patterns are alternately reversed against manual resistance the technique is referred to as slow reversal.

Slow Reversal Hold Technique

When an isometric ("hold") contraction is added to the termination of each isotonic reversal contraction the technique is designated as Slow Reversal Hold.

Rhythmic Stabilization

Repeated alternate isometric cocontraction of antagonistic and associated synergistic muscles of the neck is known as rhythmic stabilization and can be carried out in any motion patterns: (a) straight (flexion, extension, or lateral); (b) spiral diagonal flexion-extension pattern. These exercises are repeated ten to forty times and various combinations of motion patterns and techniques may be employed which fulfill best the therapeutic needs of the patient.

C. MOTION PATTERNS:

1. The manual resistive exercises may be carried out in straight motion patterns such as straight flexion, extension or lateral flexion with emphasis on either the long or short flexors or extensors, whichever is weaker.
2. Diagonal spiral motion patterns combine the activity of several motions into one. The basic motion patterns are those of flexion and extension combined with rotation to the right or to the left around the long axis of the body and the combined actions carried diagonally across the sagittal plane of the body from right to left or from left to right. Emphasis is usually placed on neck flexion since the anterior neck muscles are most frequently and most extensively involved. The flexion motion pattern is usually carried out by starting with one hand of the therapist supporting the posterior and lateral aspects of the head and face, while the guiding and resisting hand is placed on the forehead opposite the supporting hand. The head and neck is rotated to one side (right or left) and either maintained in neutral position 180° or fully extended 235° (using the 360° system), or in neutral position 0° to extension position 45° (using 180° system), bringing the ear toward the shoulder on the same side with the chin elevated (head rotated around the transverse axis). The patient is instructed to raise his head ("pull") and move it diagonally toward the opposite shoulder while at the same time gradually rotating his chin toward the opposite shoulder.

The extension spiral diagonal pattern is exactly the reverse of the flexion spiral diagonal; the resistive force is reversed; the former supporting hand becomes the resisting and guiding hand and the former guiding and resistive hand becomes the supporting hand.

Manual resistive exercises used for respirator patients are identical with those used in the treatment of paresis or paralysis of the neck muscles of patients having no breathing difficulty.

One of the objectives in developing muscle power in the neck muscles is to build them up sufficiently to utilize their

proprioceptive impulses to assist in reinforcing the innervation of the diaphragm and abdominal muscles as well as other severely paralyzed muscles of the trunk and extremities.

Resistive exercises for the muscles of inspiration are grouped arbitrarily into three topographic groups related to the application of the resistive force of the hands—the lower costals, the mid-costals, and the upper costals (fig. 6). These exercises are performed as bilateral manual resistive exercises when the

Fig. 6—Manual heavy resistive exercises, lower costal type.

patient is either in or out of the respirator. Similar types of manual resistive exercises are performed by the expiratory muscles located on anterior and lateral portions of the chest and are classified as anterior and lateral expiratory exercises. The patient makes a maximal voluntary exhalation while the therapist resists the expiratory effort made by the patient.

Inspiratory exercises are carried out as a series of inspiratory efforts or may be alternated with expiratory exercises. These resistive exercises may be performed five to fifty times during a treatment period with appropriate rest intervals. When indicated, positive pressure breathing with or without oxygen may be employed during the rest periods.

Reinforcement Exercises: The principle of reinforcement by synaptic facilitation has been adequately and extensively described in the publications of Kabat.[5-10] The application of some of these principles to the treatment of poliomyelitis patients has been described elsewhere by Huddleston, et al.[11] When expressed simply in conventional physiological terms, it may be said that proprioceptive impulses from above or below the involved segmental areas in the exercise pattern, combined with the centrifugal impulses supplied by the pyramidal and extra-pyramidal systems, unite to effect maximal excitation of the largest number of motor units capable of being activated in the final common path of any given activity pattern. The techniques of the reinforcement exercises likewise have been described by Kabat. The reinforcement exercises for the respiratory muscles consist of resistive exercises of the neck, trunk, upper extremities and at times the lower extremities. They are employed as isometric or isotonic contractions of reinforcing muscles combined with similar contractions of the respiratory muscles.

Some of the reinforcing exercise procedures which are used to augment a return of voluntary and reflex function of respiration may now be considered. Manual resistance is applied to as many of the accessory muscles of respiration as possible. These include the nasal, buccal, pharyngeal, laryngeal, scaleni, and ribbon muscles, as well as the long and short neck flexors. In the early stages of the neuromuscular re-education program, the smaller muscles of the face, mouth and neck are used to reinforce the respiratory muscles but as recovery continues the larger long and short neck muscles are utilized. Owing to the segmental morphological development of the neck muscles and the diaphragm and their closely related segmental innervation, cervical nerve roots C 3, 4, 5, 6, the neck muscles are particularly useful for reinforcing the contraction of the diaphragm (the most important inspiratory muscle). Still later the neck flexors are used to reinforce the expiratory muscles, the intercostals, the posterior serratus, and especially the abdominals.

As a rule, bilateral, symmetrical, straight pattern exercises are employed in the reinforcement exercises of the neck. Shoulder elevation against resistance is used to reinforce muscles of inspiration and shoulder depression to reinforce the muscles of expiration, using bilateral symmetrical patterns. Bilateral

symmetrical exercises of the shoulder are synchronized with the respiratory muscles using straight and diagonal patterns (fig. 7). As a general rule, shoulder

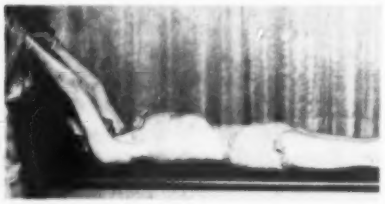

Fig. 7—Reinforcement of respiratory muscles by use of bilateral heavy resistive exercises (isotonic and isometric contractions) of the muscles of the shoulder and upper extremities, combined with breathing exercises.

flexion is synchronized with inspiration and shoulder extension with expiration. Adduction and abduction of the shoulder may be combined with flexion and extension in order to utilize diagonal patterns. On occasion, pronation and supination may be combined with internal and external rotation to add the spiral, rotatory movements to the diagonal patterns. Such combinations of muscle action employed in the bilateral symmetrical diagonal patterns activate proprioceptive impulses from a large portion of the muscle mass of both upper extremities, upper trunk, and lower extremities. This volume of proprioceptive impulses may be utilized in effecting synaptic facilitation of the respiratory muscles. Unilateral manual resistive exercises of the shoulder, using either straight or diagonal patterns are utilized to overcome the asymmetry or muscle imbalance of the chest, abdomen, and diaphragm.

Another effective means of reinforcing and exercising the abdominals and diaphragm is to employ slow stabilization of the muscles of the shoulder girdle with the arms in mid-position between flexion and extension (ninety degrees flexion) while the patient holds his breath in the inspiratory or in the expiratory phase of respiration. The stabilization may be done in other positions of the shoulders throughout the 180 degrees of flexion.

Reinforcement exercises, using isotonic or isometric contractions of the muscles of the lower extremities, may also be used to develop respiratory muscles. These are especially useful for patients who have flail or practically flail upper extremities. Hip flexion, knee flexion, and ankle dorsi-flexion may be combined with inspiration and hip extension. Knee extension and plantar flexion may be combined with expiration. The reinforcing exercises may be performed with the knees straight or with the knee flexion pattern and may be either bilaterally symmetrical or asymmetrical. Usually an isotonic contraction is followed by an isometric contraction. However, slow stabilization (alternate or synchronous isometric contractions of antagonists and synergists) may be utilized in some patients. Unilateral flexion, flexion adduction, flexion abduction, and straight lateral adduction and abduction may be employed to reinforce the abdominal muscles and diaphragm. Maximal exertion of the lower extremities as a rule produces simultaneous contraction of the muscles of the thorax and shoulder girdle and may include those of the neck and upper extremities as well. Unilateral extension exercises, combined with adduction or abduction, or straight extension may be used; but the emphasis is placed upon the flexion patterns. Unilateral reinforcement exercises are invaluable in equalizing muscle power imbalance in any of the respiratory muscles.

Another type of reinforcement procedure is to combine a contraction of the neck flexors with hip and knee flexion or to combine the neck flexors with the upper trunk flexors. Occasionally a combination of shoulder extension and hip flexion on the ipsilateral or contralateral side of the body may be employed to reinforce the contraction of trunk muscles. Flexion of the hip and knee may be combined with shoulder extension ipsilaterally and contralaterally. These reinforcement exercises not only improve the mechanism of pulmonary ventilation, but build power and endurance in the muscles of the lower trunk and extremities as well. The use of the Bennett flow-sensitive positive-pressure appara-

tus, combined with oxygen, combats fatigue and allows more extensive and more vigorous treatment. Neuromuscular re-education therefore is augmented by prescribed periods of positive pressure breathing.

Abdominal Support: Adequate abdominal support is very important in patients with extremely weak abdominal muscles. This is particularly true when they have recovered sufficiently to stand or be stood erect. The abdominal support may be supplied in the form of a binder, a corset, or a plastic, "celastic," jacket. In the early stages of treatment in the respirator, the abdominal binder or corset may be utilized to augment the range of motion of the chest and to increase costal breathing. Intermittent constriction of the abdomen with a binder and increasing the negative intratank pressure may be employed as a treatment procedure.

When the patient has recovered sufficiently to use a wheel chair or to start standing balance, it is of paramount importance to select the type of garment, brace or jacket which will provide adequate abdominal support but will not interfere with pulmonary ventilation.

Chest Respirators: Some patients require prolonged breathing assistance and it may be desirable to substitute a simplified regional respirator for the tank respirator. Two types of chest respirator are available: one enclosing the entire chest and upper abdomen within the jacket (Blanchard); the other consisting of a shell or cuirass (Monaghan or Huxley). Largely because of simplicity of application, the cuirass respirator is the type usually employed. The Monaghan type of chest respirator may be used therapeutically to help the patient increase pulmonary ventilation by increasing the positive and negative pressures to tolerance and combining the alternate pressure changes with maximal voluntary inspiratory and expiratory efforts. This type of treatment may be augmented by applying positive pressure breathing with a mask, utilizing the Bennett Valve type of apparatus and in some instances may be supplemented still further by applying manual resistance to the shell of the respirator. The manual resistance may be applied using the cuirass respirator alone or in combination with the positive pressure breathing apparatus.

Clinical Observations

Ventilation studies have been conducted on a series of respirator, post-respirator, and part-time respirator patients to evaluate the efficacy of the techniques just described. Eight adult female patients, two adult male patients, and two female children are included in the present series. The adult females range in age from 25 to 44 years, the adult males are 35 to 43 years of age respectively, and the children 4 and 5 years of age respectively. A period of three to fifteen months elapsed from the onset of poliomyelitis with respiratory paralysis to the time of transfer to the Kabat-Kaiser Institute for Neuromuscular Rehabilitation. The duration of treatment at the Institute in this group of patients varied from three to ten months. Three of the patients arrived as full-time respirator cases and of this group one patient had a patent tracheotomy and required combined pressures (negative and intra-tracheal positive) and fairly frequent suctioning. The vital capacity measurements of two of these individuals were 125 cc. and 150 cc. respectively on admission.

One post-respirator patient was admitted whose initial check revealed a vital capacity of 400 cc. This patient developed signs of chronic hypoxia, including headache, irritability, insomnia and lack of concentration a few days after the initiation of an intensive re-education program. She was immediately returned to a tank respirator for eight hours during each night for several weeks, followed by gradual reduction in respirator use to every other night and then every third and fourth night. In less than two months this patient increased her vital capacity from 400 cc. to 925 cc. and was then allowed out full time. Two months later her vital capacity had increased to 1300 cc.

Two other patients arrived in Monaghan chest respirators for night

use and one child was admitted as a part-time tank respirator case. Thus, of the twelve patients included in this clinical study, six at the time of admission required full-time or part-time respirator assistance. The lowest vital capacity measurement in the series on admission was 125 cc. Of the ten adult male and female patients, six had a vital capacity measurement of 80 cc. or less. Both children had less than one-half of their calculated normal vital capacity. In all instances the Bennett Respiratory Ventilation Meter was employed for measuring the vital capacity. The normal calculated vital capacity was obtained from a vital capacity standard table used at the Los Angeles County General Hospital Contagious Disease Unit.

Table 1 reveals the pertinent data for the series of twelve patients with respiratory muscle paralysis resulting from acute bulbo-spinal or spinal poliomyelitis who were treated with mobilization and resistive exercise techniques for periods ranging from three to ten months. The vital capacity measurements show increases varying from 150 cc. to 950 cc. All cases show an increase in the flexibility of the chest, a reduction of mucous secretion when this was present at admission, and an increased tolerance for intensive treatment. All of the patients, with three exceptions, have developed a sufficient reserve to obviate the need for respirator assistance. Of the three exceptions, one patient continues to use the Drinker respirator only at night and the other two patients use the chest respirator only at night. The latter are being weaned from their Monaghan respirators at the present time. Although the group of patients presented in this study is small, and while we admit the need for further extended observations, it is our impression that respiratory muscle paralysis resulting from poliomyelitis can be effectively combatted during the convalescent and chronic stages by means of the therapy discussed in this paper.

Summary

A resumé of the treatment program of anterior poliomyelitis patients with respiratory paralysis which has been adapted at the Kabat-Kaiser Institute for Neuromuscular Rehabilitation in Santa Monica, California, has been presented. This treatment procedure includes:

(1) Extensive ventilation studies making repeated measurements of pulmonary fractions, particularly tidal air and vital capacity.
(2) Proper positioning of the patient.
(3) Treatment of intercostal spasm by means of packs and early and continued manual mobilization therapy.
(4) The use of positive intra-pulmonic and negative intra-tank respiratory pressures.
(5) Supplemental respiratory exercises, combined with the use of an abdominal binder when indicated.
(6) Pulmonary ventilation exercises, used separately, with the positive pressure breathing equipment provided either by the attachments of the tank type respirator or by the Bennett flow sensitive positive pressure apparatus, or using combined negative intra-tank and positive intra-pulmonic pressures.
(7) Treatment of muscle paresis and muscle paralysis by means of manual resistive exercises, combined with reinforcement exercises to augment synaptic facilitation of the remaining undamaged motor neurons. The combination of manual resistive exercises and reinforcement techniques is believed to be effective in many cases in restoring the return of adequate pulmonary ventilation.
(8) Three additional therapeutic techniques, and their application to the treatment of anterior poliomyelitis patients with respiratory weakness and paralysis, which are not customarily employed in the physical treatment of such cases are described, namely: (1) early and prolonged mobilization therapy; (2) early and extended use of manual resistive exercises, and (3) early and continued use of reinforcement techniques to facilitate the motor response of the muscles

TABLE I

Patient Summary (Age, onset, type of "polio")	Normal Vital Capacity (cc.) (Calculated)	Vital Capacity (cc.) when placed in Respirator	Lowest Vital Capacity (cc.)	Removed from Respirator (mo. after onset)	Time (mo.) from onset to transfer to K.K.I.	Vital Capacity (cc.) at time of transfer	Respirator Status at Transfer	Time (mo.) at K.K.I.	Respirator Status at present	Vital Capacity at present (cc.)
H.L. 27 yr. old female										
Acute onset — Sept. 12, 1951	3000	1000	125	——	14 da.	125	Respirator negative pressure	10 mo.	Chest Respirator at night only	650
Bulbo-spinal "polio" — severe										
L.K. 35 yr. old male										
Acute onset — Nov. 12, 1950	4500	<100	<100	6½ mo.	3 mo.	150	Combined pressure	6 mo.	Positive pressure at night only	1100
Bulbo-spinal "polio" — severe							Tracheotomy			
H.G. 36 yr. old female							Respirator		Out	
Acute onset — Sept. 27, 1950	3200	<100	<100	18 mo.	15 mo.	700	negative pressure	8 mo.	full time	1050
Bulbo-spinal "polio" — severe										
P.J. 25 yr. old female							Out			
Acute onset — July 28, 1951	4200	800	150	4½ mo.	5 mo.	1150	full time	8 mo.	——	1500
Bulbo-spinal "polio" — mod. severe										
D.T. 25 yr. old female							Out			
Acute onset — July 4, 1951	3400	1700	500	5 mo.	5+ mo.	1300	full time	8+ mo.	——	1660
Bulbo-spinal "polio" — mod. severe										
M.M. 43 yr. old male							Out			
Acute onset — Dec. 1, 1950	4300	1400	1400	1 mo. to Rocking Bed	12 mo.	2700	full time	8½ mo.	——	3200
Bulbo-spinal "polio" — mod.										
M.O. 29 yr. old female				To chest			Chest		Beginning	
Acute onset — Oct. 20, 1951	3300	950	250	Respirator 4 mo.	5 mo.	800	Respirator at night	5½ mo.	to sleep out	1125
Bulbo-spinal "polio" — severe										
M.C. 42 yr. old female				To chest			Chest		Beginning	
Acute onset — Aug. 15, 1951	3200	350	125	Respirator 8 mo.	9 mo.	725	Respirator at night	3½ mo.	to sleep out	1025
Bulbo-spinal "polio" — severe										
*R.P. 29 yr. old female							Out			
Acute onset — Oct. 11, 1951	3250	?	?	3 mo.	5 mo.	400?	full time	5 mo.	——	1300
Bulbo-spinal "polio" — severe										
V.G. 29 yr. old female							Out			
Acute onset — Oct. 23, 1951	3300	1400	200	5 mo.	6 mo.	1275	full time	4 mo.	——	1575
Bulbo-spinal "polio" — severe										
C.F. 5 yr. old female							Out			
Acute onset — Nov. 7, 1951	820	<100	<100	4½ mo.	5 mo.	400	full time	6½ mo.	——	550
Bulbo-spinal "polio" — severe										
L.R. 4 yr. old female							In		Out	
Acute onset — July 9, 1951	700	<100	<100	7½ mo.	7 mo.	325	every 3rd night	6 mo.	full time	600
Bulbo-spinal "polio" — severe										

*Transfer from another County — Developed hypoxia after beginning intensive therapy — Placed in respirator nightly for 2 months after admission to K.K.I.

of respiration; the combination of manual resistive exercises and reinforcement techniques is used as the basic principles of neuromuscular re-education.

(9) Clinical observations have been recorded on a series of twelve patients with respiratory muscle paralysis. Progress reports include periodic tabulation of ventilation studies. All patients, with three exceptions, have developed sufficient reserve to discontinue the use of the respirator. One patient continues to use the tank-type respirator only at night and the other two patients use the chest respirator at night, indicating that poliomyelitis patients with respiratory paralysis can be treated effectively during the convalescent and chronic stages by means of the treatment program presented in this paper. Although the group of patients presented in this study is small, it is our impression that respiratory muscle paralysis resulting from anterior poliomyelitis can be effectively corrected during the convalescent and chronic stages by means of appropriate physical treatment such as we have outlined.

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Discussion

Dr. Hart E. Van Riper (New York, N.Y.): The American Congress of Physical Medicine has, on one previous occasion, extended to me, a non-member, the privilege of discussing one of the papers presented. It seems my sad lot on this second invitation to be realistic again, well recognizing the fact that in my criticism it will be impossible to avoid personalities. The Congress is, however, a scientific group, and if we cannot be direct and criticize ourselves within our closed meetings, then there is little object in holding scientific meetings or providing for the discussion of papers that are presented.

In no single year could we find a more timely discussion than the one presented by Doctor Huddleston on "Studies on Anterior Poliomyelitis Patients with Respiratory Paralysis." The rising incidence of this epidemic disease in 1952 would indicate that this year will record the single largest number of poliomyelitis patients ever reported in the records of the United States Public Health Service. The problem is of even

greater urgency to The National Foundation for Infantile Paralysis, since reports from isolated epidemic areas would seem to indicate that somewhere between 20 and 25 per cent of all of the reported cases will have had, at some time during the course of their disease, bulbar or respiratory involvement. Reports from our Director of Technical Equipment show that more respirators have been purchased this year than in any previous three year history, and at the present rate at which respirators are being transferred from one epidemic area to another, it would appear that more respirators will have been in use for more patients in 1952 than in the previous four years of high poliomyelitis incidence.

Recognizing not only the cost of the respirator equipment but in addition, considering the cost of transportation of such equipment along with the cost of hospitalization, the need for additional nursing services for respirator patients, coupled with medical care and physical therapy, it is obvious that this single category of poliomyelitis patient represents a great financial liability not only to The National Foundation for Infantile Paralysis, but also to hospitals and to the individual patient or the family that is supporting the cost of care.

Unfortunately, Doctor Huddleston's paper did not arrive in time for me to prepare for presentation a critical review of its contents, and at this clinical session this morning he has merely presented to you a summary of his paper, devoting the time allotted for his presentation to a demonstration of the techniques which have been developed at the Kabat-Kaiser Institute for Neuromuscular Rehabilitation at Santa Monica for the treatment of respiratory paralysis.

Doctor Huddleston has failed to recognize that there are presently in operation five centers for the care of respiratory paralysis supported by grants of funds from The National Foundation for Infantile Paralysis. In these five institutions there are congregated together something over 100 patients, some of them in the acute stage of the disease and others who have been confined to respirators for periods of time extending to more than two years. These centers are established not only for the care of the patient and the clinical research which may come from their observation, but also to permit the development and evaluation of respiratory equipment and improvements of old equipment, such as the tank respirator, which has been in use for many years. Doctor Huddleston did not mention the rocking bed, which many clinicians have found to be very effective in the treatment of patients immediately over the acute phase of the disease. Other items of equipment which have been developed and improved are too numerous to mention in the time allotted for this discussion.

Finally, may I ask that the Congress evaluate the type of therapy which was demonstrated here in connection with this paper. I do not believe that the number of cases presented, or the demonstration which we have witnessed gives us sufficient clinical material upon which to make a definitive evaluation of this technique. Any of us, however, who have visited treatment centers in the past years and have observed the shortage of personnel and the tremendous numbers of patients requiring the services of these trained persons, namely physical therapists and physiatrists, must honestly question whether or not we can find some other means which will provide this type of therapy at a saving in man hours, for it is the cost of personnel services in our hospitals and treatment centers today that constitutes the greatest percentage of the overall cost. No single one of us wants to deny a patient with poliomyelitis of the respiratory, bulbar or spinal type, every advantage for the greatest possible recovery, but in our desire to benefit the patient we must be realistic and repeatedly ask ourselves, "Is there sufficient money to provide a specific type of treatment at greater cost when other methods are or can be made available which will be perhaps equally beneficial ultimately to the patient?"

A Comparison of Skin and Muscle Temperatures Following Hot Foments, Dibenamine® and Priscoline® in Acute Poliomyelitis

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LARCHMONT, N. Y.
and
JAMES G. KRAMER, M.D.
AKRON, OHIO

Until very recently, the use of hot foments in the treatment of acute poliomyelitis has been the chief therapeutic approach for the relief of muscle pain and spasm. Smith introduced the use of Priscoline® (2-benzyl-4,5 imidazoline) hydrochloride, an adrenergic blocking agent, as a substitute for hot pack therapy.[1] The rationale for the use of this drug was related to the autonomic imbalance in acute poliomyelitis in which the sympathetic nervous system is hyperactive.[2] This was thought to produce vasospasm and muscle ischemia. As the physiologic mechanism behind hot foments is probably related chiefly to increased blood flow, it was thought that an evaluation of the muscle temperature changes resulting from the use of Priscoline® hydrochloride and Dibenamine® (N, N-dibenzyl-b-chloroethylamine) as compared with hot packs was indicated. Because information on the temperatures of normal, "spastic" and paretic muscles in poliomyelitis without treatment had not been established, the primary study was to evaluate the temperature findings in the untreated state, followed by a comparison of the various means of therapy.

Method

Patients studied were in the acute stage of poliomyelitis but were afebrile. Muscle temperature determinations were made by means of a Leeds and Northrop continuously recording potentiometer. Muscle temperatures were studied by means of iron constantan thermocouples inserted in #19 two-inch needles. The needles were inserted obliquely into the muscle being studied, up to a depth of about two inches. Skin thermocouples were attached by adhesive tape. Although a constant temperature room was not available, temperature variations were minimal and were recorded frequently. A cradle was placed over the extremity being studied.

Before any form of therapy was instituted, a trial period of one-half hour was observed so that standard conditions might prevail. Although the patients were not in an absolute basal state, it was felt that within the limitations of the disease, the extraneous psychological and physical factors were largely eliminated. Recordings were made during periods varying from three to eight hours depending on the temperature response. In the case of hot pack temperature measurements, thermocouples were inserted between the skin and the pack. Priscoline was injected intramuscularly in doses of 25 mg. for children under ten years of age and between 50 and 100 mg. for children over this limit and adults. Dibenamine was given intravenously in doses of 6 mg. per kilogram following an initial intravenous injection of 1½ to 3¾ grains of amobarbital (amytal® sodium).

Identification of spasm was made by clinical observation only. The criteria for identifying spasm consisted of limitation of motion, stretch pain, and muscle tenderness, relief of the spasm being followed by multiple goniometric determinations. The muscles classified as weak consisted of 0 to 3+ muscle strength. The "normal" muscles were unaffected muscles of acute poliomyelitis

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cases; no studies of unaffected patients were made. The muscles tested were the gastrocnemius, quadriceps and hamstrings. Examination was limited to this group because of the technical ease and the patient's comfort.

Results

In the group of 19 muscles which were clinically in spasm, it was found that the mean temperature before therapy was 99.3 F. This was higher than either the paretic or normal muscles. The response in terms of increased muscle temperature to drug therapy and hot packs was noted to be greater in paralyzed muscles than in the normal or spastic group as seen in figure 1. The mean increase of temperature in paralyzed muscles following all forms of therapy was 1.8 F. The greatest increase was 2.0 F. following Priscoline as compared with 1.8 F. for hot packs and 1.0 F. with Dibenamine (table 2). The increase in muscle temperature of the spastic and normal muscles to all forms of therapy was approximately the same except for the increase of 1.5 F. observed in the normal muscles following hot packs. This group, however, was too small to be statistically significant.

As seen in figure 2, an examination of the time necessary to reach the greatest increase in muscle temperature revealed that following application of the hot packs, the muscle temperature rapidly rose to its maximum within a period of 20 to 30 minutes, was maintained for 40 minutes, and fell rapidly to its original temperature within a period of 120 minutes. Along with this observation, it was noted that the mean temperature of the hot packs when applied was 106.9 F., but individual packs were observed as high as 120 F. The dissipation of heat was rapid, and within a period of 10 minutes the average pack had reached the temperature of the skin and at 30 minutes had leveled off completely and no further heat was lost (fig. 3, 4, and 5).

The muscle temperature reached its peak 80 minutes following intramuscular Priscoline. The temperature remained elevated for an average of 135 minutes, although some cases were observed to remain elevated considerably longer. The mean increase of all muscle temperatures following Priscoline was greater than the other two modes of therapy, being 1.3 F. (fig. 2 and 6). Despite the fact that the histamine-like flush disappeared at

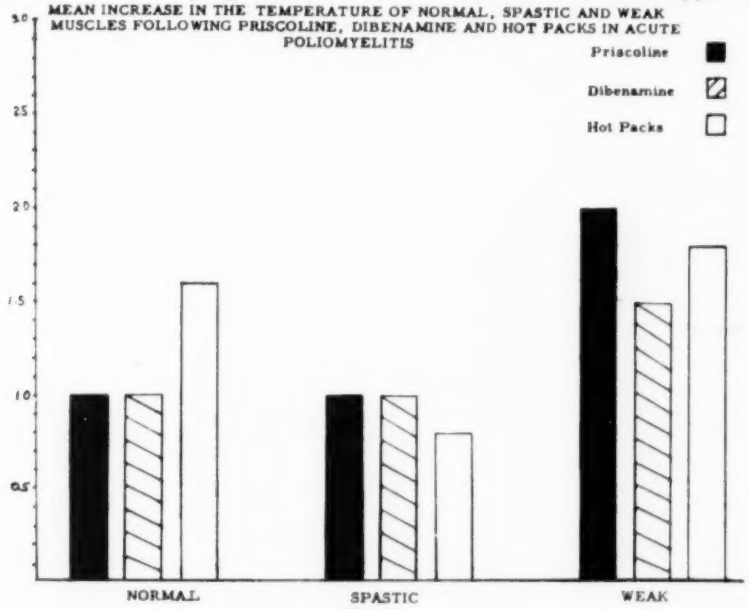

Fig. 1.

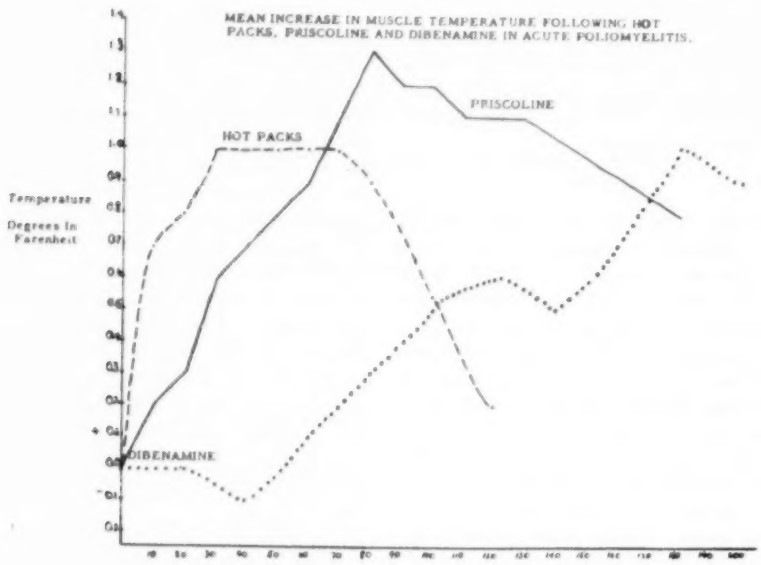

Fig. 2.

approximately the same time the muscle temperature reached its maximum, it was observed that subsequent cutaneous vasoconstriction did not increase the muscle temperature. Conversely, however, it has been thought that cutaneous dilation through the use of hot foments can cause a diminution in deep circulation.[8]

Dibenamine produced a slower rise in muscle temperature because of its slow rate of administration, which lasted from 1 to 1½ hours. However, within a period of 2 hours it had reached 60 per cent of its mean increase and at 3 hours approximated the temperature of the muscles

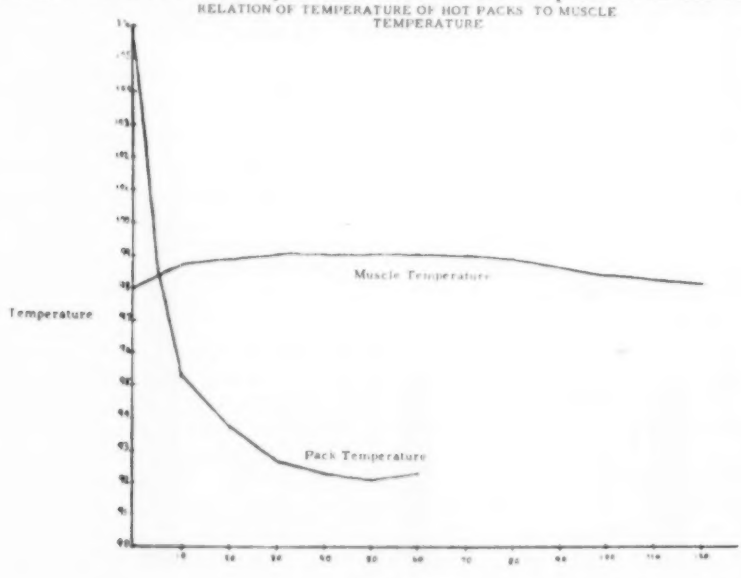

Fig. 3.

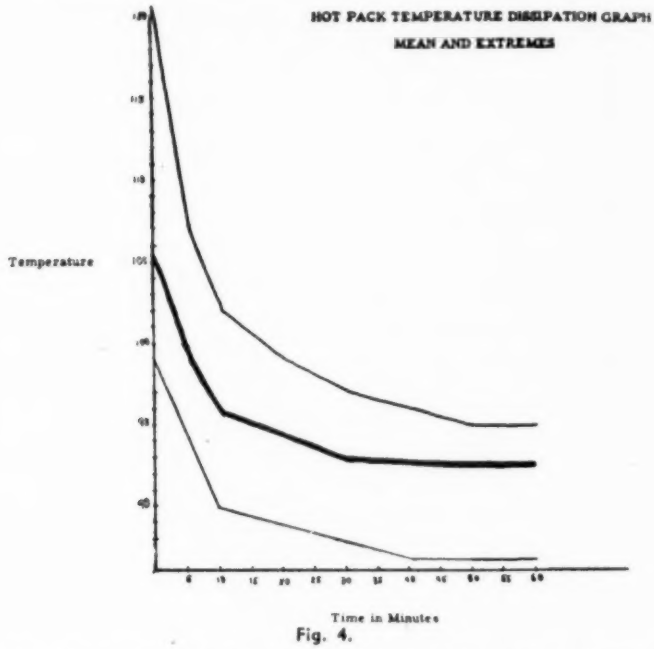

Fig. 4.

treated with hot packs with a net increase of 0.8 F. Because of its length of action, the duration of increased muscle temperature could not be determined. It was thought that the alleviation of symptoms probably corresponded with the changes in muscle temperature, which would indicate that the increase remained from 48 to 96 hours (fig. 7). Statistical analysis of the results, as

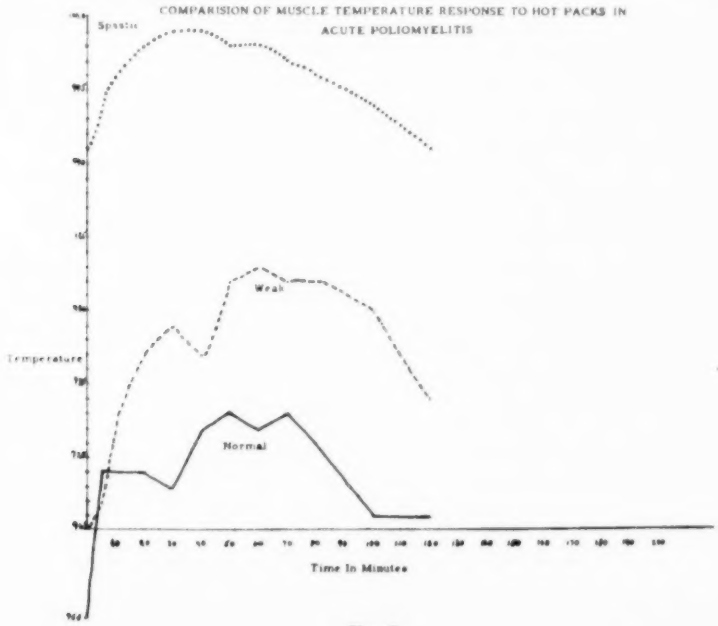

Fig. 5.

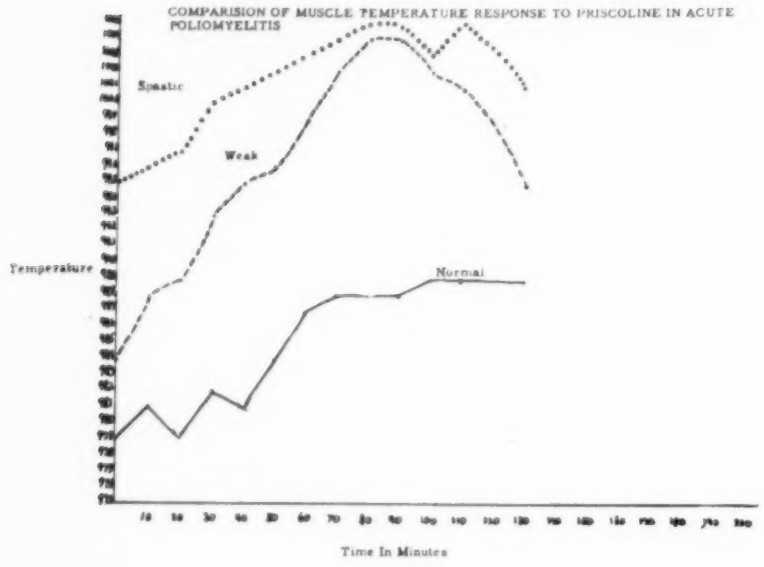

Fig. 6.

stated, indicates that the response of the three muscle groups to Priscoline was significant; however, a larger muscle group must be tested to substantiate the Dibenamine and hot pack group data (table 1).

Measurement of skin temperatures did not reveal any marked diminution below the normal patient, as has been reported by Smith,[2] in which the extremities may be cold, mottled or cyanotic. Initially, the Dibenamine group had a mean skin

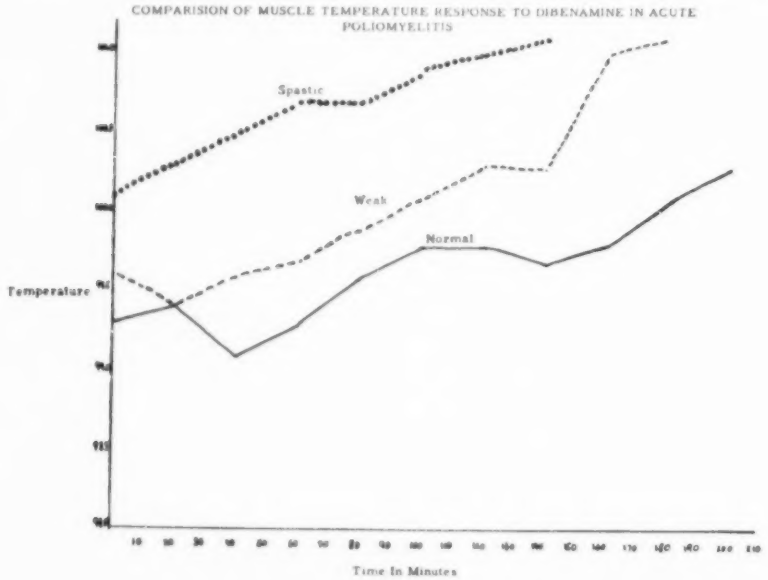

Fig. 7.

TABLE 1—Temperature Changes in Weak, Spastic, and Normal Muscle Groups Resulting from Priscoline, Dibenamine, and Hot Pack Therapy.

Muscle Category	Weak	No. of Muscles	Spastic	No. of Muscles	Normal	No. of Muscles
I. Priscoline						
Mean Temp. (Degrees F)						
Before Therapy	98.4	9	99.5	7	97.0	6
After Therapy	100.4	9	100.5	7	98.9	6
Difference	2.0***		1.0**		1.0*	
II. Dibenamine						
Mean Temp.						
Before Therapy	99.6	6	100.1	2	99.4	10
After Therapy	100.6	6	101.1	2	100.0	10
Difference	1.0		1.0		.6	
III. Hot Packs						
Mean Temp.						
Before Therapy	96.5	3	99.1	10	95.8	3
After Therapy	98.3	3	99.9	10	97.3	3
Difference	1.8		.8		1.5	

*** Significant at .1% level
** Significant at 1%
* Significant at 5%

TABLE 2—SUMMARY OF SKIN TEMPERATURE DETERMINATIONS

	Temperature before therapy	Temperature after therapy	Mean increase
Dibenamine	94.7	97.7	2.5
Priscoline	95.6	97.0	1.9

temperature of 94.7 F., while the Priscoline group had 95.6 F. The average increase was 2.5 F. following Dibenamine and 1.9 F. after Priscoline, although clinically the skin appeared warmer following Priscoline as the result of the transient histamine flush. Average duration of increased skin temperature for Priscoline was 123 minutes and for Dibenamine over 240 minutes. The latter temperature increase paralleled the muscle temperature increase but recordings were not done longer than 8 hours. Skin temperatures for hot pack therapy were not done (table 2).

Discussion

The changes in muscle temperature have been correlated somewhat with actual blood flow by Hines' studies[4] but may be presumed to serve only as a rough guide to the increase in total blood volume to the extremity. Regarding hot pack therapy, it has been shown in experimental animals that the application of one pack for a period of 5 minutes increased the subcutaneous temperatures 5.4 C., but that the blood flow for this period of time was only slightly increased. However, application of three consecutive hot packs increased the blood volume and temperature a substantial amount. Following the removal of the third pack, the increase in muscle blood supply remained for 20 to 40 minutes[4].

These observations suggest that the application of pin packs for longer than 20 minutes is not necessarily of any further value, except to prevent heat loss. Application of hot packs to denervated and anesthetized limbs of experimental animals has been shown by Hines to cause a less pronounced rise in muscle temperature and blood flow[4], as opposed to our study of three paretic muscles in human subjects where the mean increase was greater than in the normal muscles. The significance of this, however, is limited by the small number of studies.

It can probably be presumed that the increase in muscle temperature following Dibenamine and Priscoline represents an increase in the blood flow although other physiologic studies in this disease, such as plethysmographic, have not been carried out as yet. Because of the gross nature of temperatures as an evaluation of muscle blood flow, a comparison between drug and hot foment therapy cannot be made with this criterion. However, it would seem that they are at least comparable in terms of temperature increases.

The finding of an elevated temperature of muscles in spasm over paretic and normal muscles is paradoxical, but may be on the basis of increased muscle metabolism from muscle fibre contraction. Despite the presence of the normal blood supply, this may predispose toward a state of relative ischemia. The increased flow of blood may therefore relieve this condition either by supplying oxygen for synthesis of glycogen from lactic acid or may aid in removing waste products. It is interesting to note that other workers demonstrated an almost exact increase in muscle temperatures as was observed in this study following the use of Priscoline[5].

Paretic muscles, before atrophy, were noted to have a greater temperature than unaffected muscles. It is known, however, that fibrillation occurring in a denervated muscle causes an increase in muscle metabolism and temperature[6]. Why the response was greater in this

group of muscles following sympatholytic therapy is open to question; but it may be speculated that hypersensitivity to acetylcholine, a mechanism of increasing fibrillation, may occur or may be enhanced with the use of these drugs.

The difference between absolute temperature observations in studying the response to hot packs results from variations in technique. Gucker in his work noted greater increases in muscle temperature when using #23 hypodermic needles as compared with 2 inch #19 needles due to the difference in the depth of insertion[5].

Further inquiry into the vascular picture of muscles in acute poliomyelitis must include methods divorced from variations in metabolism such as that advocated by Kety using Na^{24}[7]. The metabolic picture before and after therapy should be studied by noting alterations in muscle pH. Investigations by Hines thus far on experimental animals have indicated that P^{32} uptake in spastic muscles is less than observed in normal muscles; however, the original muscle temperature in the spastic muscles was lower than in the normal controls[8]. It is obvious, therefore, that further studies will be necessary, especially as to the vascular status of these muscles, before the physiological components of "spasm" can be described.

Conclusions

1.—The temperature of muscles in spasm in acute poliomyelitis is greater than that of paretic or normal muscles, the latter being lower than either of the other two groups.

2.—The response of muscle temperatures to Dibenamine and Priscoline is comparable to or greater than that of hot packs. The length of time that the increased temperatures remain is slightly longer with Priscoline than hot packs; and, in the case of Dibenamine, they may last 96 hours.

3.—Greater responses to drug therapy were noted, in terms of muscle temperature, in the weak muscles than in the other two groups. It is postulated that this may be due to an enhancement of the hypersensitivity to acetylocholine causing an increase in muscle fibre fibrillation.

4.—The major dissipation of heat from hot packs occurs within 10 minutes and the temperature reached that of the skin within 30 minutes

5.—No unusually low skin temperatures were observed and the elevation of skin temperature was more marked following Dibenamine than Priscoline.

6.—It is thought that a relative muscle ischemia may exist in spastic muscles as a result of increased metabolism and that vasodilation by hot foments or adrenolytic therapy may aid either by eliminating the waste products, or by reoxygenation.

7.—Further studies in terms of muscle blood flow and metabolism are indicated before the mechanism of muscle spasm can be explained fully.

Acknowledgement — This study was supported by a grant from Ciba Pharmaceutical Products, Inc. Dibenamine was supplied by Smith, Kline & French Laboratories. Mr. Benjamin B. Weybrew, U. S. Naval Medical Research Laboratory, New London, Conn., supplied the statistical analysis.

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The Effect of Venous Compression on the Circulation of the Extremities

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LOS ANGELES

Since the early description of the beneficial effects of hyperemia by Bier[1] in 1907, various methods to produce this effect have been devised[2]. Lewis and Grant[3] produced an increase in arterial flow after venous congestion. Collens and Wilensky[4] employing intermittent venous occlusion reported relief of intermittent claudication and good results in the treatment of 124 patients with peripheral vascular disease. Kramer[5] using this method found beneficial effects in 66 per cent of 30 patients with peripheral vascular disease. In certain cases, the skin temperatures were reported to be increased by 3 degrees centigrade. Brown and Arnott[6] and de Takats[7] using this procedure reported relief of coldness and numbness of the extremities in a significant number of patients with peripheral vascular disease. Certain observers, however, notably Allen and McKechnie[8], Brown and Arnott[9], Wilson and Ogston[10], and Veal and McCord[11] concluded that intermittent venous occlusion produced no increase in the rate of blood flow to the limb. Harpuder and Stein[12] stated that reactive hyperemia did not occur after the release of less than 40.0 mm. of mercury pressure. Abramson and associates[13] could not demonstrate a sustained increase in blood flow in the leg or forearm following intermittent venous occlusion. This is in accord with the work of Veal and McCord[14], who stated that intermittent venous occlusion does not produce reactive hyperemia.

The present study was carried out to determine whether intermittent venous occlusion carried out in the conventional way increases the skin temperature, the height of pulsations, or the blood flow to a toe in normal subjects and in patients with arteriosclerosis obliterans and to determine if a directional rhythmic type of limb compression favorably influences the circulation to the limbs.

Methods and Materials

Intermittent venous occlusion was tested employing the Rhythmic Constrictor*. The occluding cuff was placed at the thigh. The cuff was inflated to a pressure of 60 mm. of mercury, two minutes off and two minutes on. Measurements of skin temperatures, the volume (height) of pulsation and the volume of blood flow per second to the toe were recorded before and immediately after 20 minutes of treatment.

Directional limb compression** was carried out, using a series of 13 neoprene cuffs, automatically inflated and deflated serially, producing a band of pressure that progressed up or down the arm or leg with peristaltic motion. The cuffs were inflated to a predetermined pressure of 60 mm. of mercury, and the limbs were compressed from thigh to foot or in the reverse direction from foot to thigh by means of a selector switch. A milking effect was brought about by the simultaneous inflation of two cuffs (the upper or lower cuff served as a check valve while the next cuff in series tended

*UMI Corporation.
**The Vaso-Pneumatic, manufactured by the Poor and Logan Manufacturing Company, North Hollywood, Calif.

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**From the Department of Biophysics, University of California at Los Angeles.
This work was done in part with the aid of a grant from the Los Angeles Heart Association.

to squeeze the blood in the predetermined direction). Each sweep of the 13 cuffs occurred every five seconds; the duration of each sweep was approximately three seconds. Circulation studies of the digits of the treated limb included measurements of skin temperatures, volume of blood flow per second, volume pulsations, and total volume of a digit. In certain instances, studies of venous pressures of the internal saphenous vein, tissue pressure, skin distensibility, and superficial lymph flow were made. The room temperature was maintained at 25 ± 1.5 C. Plethysmographic records were made with a direct-writing electronic pneumoplethysmograph[15]. Blood flow was determined by the venous occlusion technic with the recording cuff at the ankle or wrist, according to the method of Goetz[16]. Skin temperatures were measured with the Brown four-point potentiometer. Venous pressures were determined by the Statham strain gauge and were recorded on the Sanborn Polyviso. Tissue pressure[17] and skin distensibility[18] were studied by the method of Burch. Rough estimates of lymph flow of the skin were made by use of an 11 per cent solution of Patent Blue dye. The rate of spread of the dye after intracutaneous injection was measured before and after limb compression. The psychogalvanic reflex was recorded by the Metrigraph Psychogalvanometer*. In most instances the results obtained with intermittent venous occlusion or with directional limb compression were compared with measurements of circulation made following ingestion of two ounces of whiskey and application of indirect body heating for 45 minutes. The latter was accomplished by means of a double-sized electric pad placed between two woolen blankets.

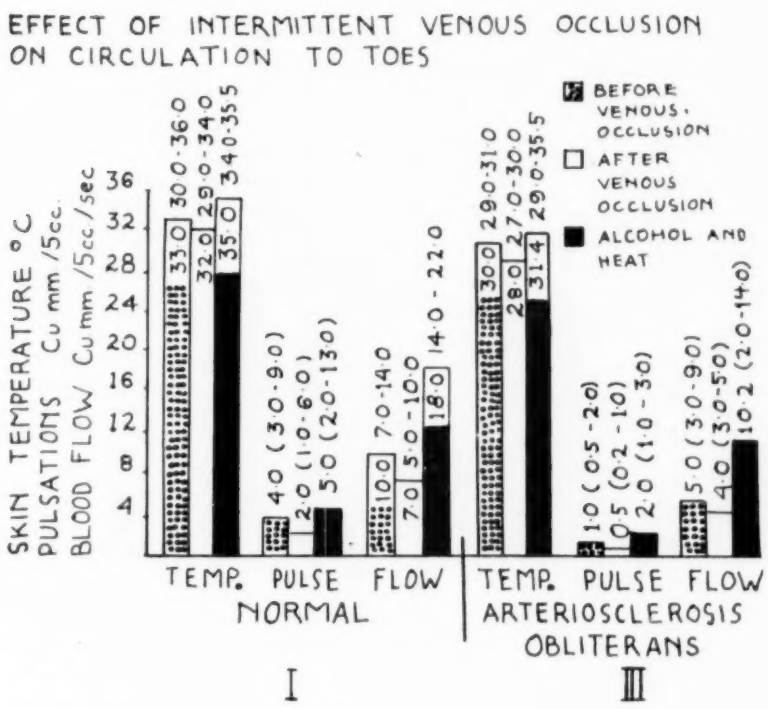
A total of 22 patients and 10 controls, with ages for the entire group ranging from 28 to 67, were studied. These consisted of four groups: group I—10 normal subjects; group II—10 patients with arteriosclerosis obliterans who had been sympathectomized three months to one year previously (all of these patients had the second or second and third lumbar ganglia removed and all had been tested adequately by means of the psychogalvanic reflex and induced vasomotor reflex of the digit to insure adequate removal and lack of regrowth of sympathetic nerves); group III—10 unsympathectomized patients with arteriosclerosis obliterans of the lower extremities who had neither ulceration nor gangrene; and group IV—2 patients with lymphedema, one a postmastectomy edema of the arm, the other a nonpitting edema of unknown origin of the leg.

*Metigraph Instrument Company, Burbank, California.

Results

1. *The Effect of Intermittent Venous Occlusion on the Circulation to the Toes*: The temperature, pulse volume and blood flow were decreased in all normal subjects (group 1) and in all patients with arteriosclerosis obliterans (group III, fig. 1). Measurements made one and five minutes after treatment were also below the pretreatment level and, without exception, alcohol and heat increased these measurements over the pretreatment values.

2. *Effect of Directional Limb Compression*: A.—The effect of directional limb compression on the blood flow to the toes was studied on subjects of groups I, II, and III (fig. 2). Resting studies were made on the blood flow and volume pulsation of the toes. Measurements were made after 20 minutes of treatment with the cuffs inflated from the foot to the thigh (up), after 20 minutes of rest (off), and after inflation from thigh to foot (down) for 20 minutes. Thirty minutes after alcohol and heat, additional readings were made. Measurements made before and after serial compression, regardless of direction, showed a decrease in the rate of blood flow to the toes, whereas a definite increase occurred after alcohol and heat. The reduction in blood flow was considerably less in the sympathectomized patients (group II) than in normal subjects (group I) or in nonsympathectomized patients with arteriosclerosis (group III).


EFFECT OF INTERMITTENT VENOUS OCCLUSION
ON CIRCULATION TO TOES
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BLOOD FLOW Cu mm /5cc /sec
BEFORE VENOUS OCCLUSION
AFTER VENOUS OCCLUSION
ALCOHOL AND HEAT
TEMP. PULSE FLOW
NORMAL
TEMP. PULSE FLOW
ARTERIOSCLEROSIS OBLITERANS
I
III

Fig. 1.

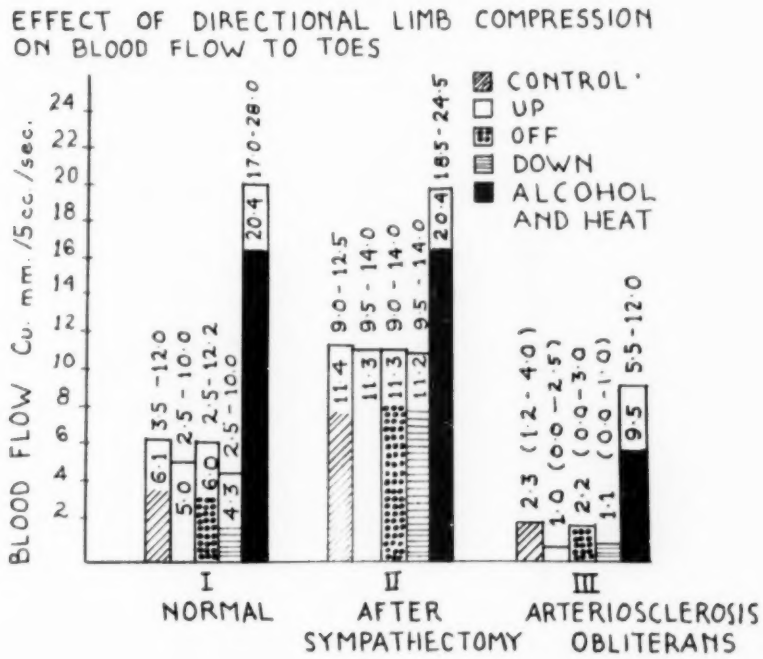
EFFECT OF DIRECTIONAL LIMB COMPRESSION
ON BLOOD FLOW TO TOES
BLOOD FLOW Cu. mm./5cc./sec.
CONTROL
UP
OFF
DOWN
ALCOHOL AND HEAT
I
NORMAL
II
AFTER SYMPATHECTOMY
III
ARTERIOSCLEROSIS OBLITERANS

Fig. 2.

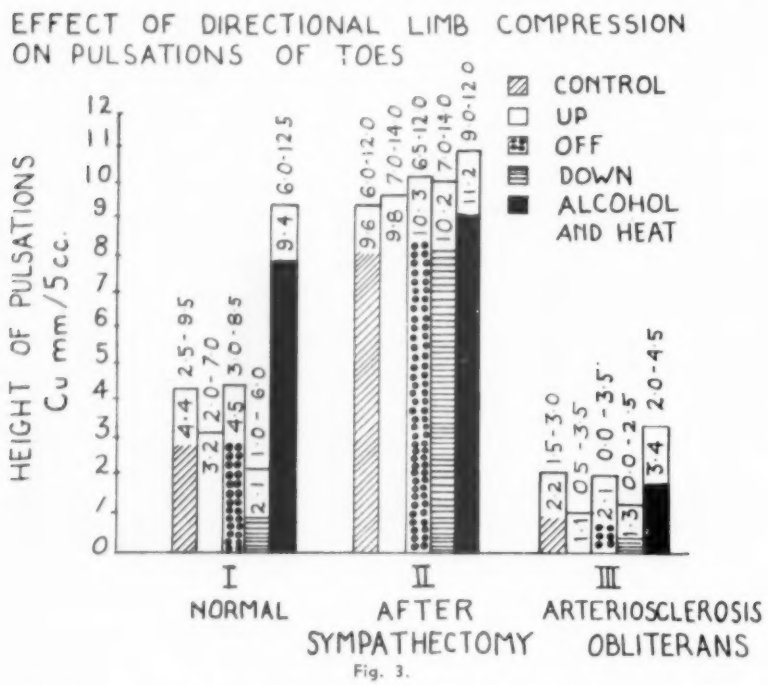
EFFECT OF DIRECTIONAL LIMB COMPRESSION
ON PULSATIONS OF TOES
HEIGHT OF PULSATIONS
Cu mm/5 cc.
CONTROL
UP
OFF
DOWN
ALCOHOL
AND HEAT
I
NORMAL
II
AFTER
SYMPATHECTOMY
III
ARTERIOSCLEROSIS
OBLITERANS

Fig. 3.

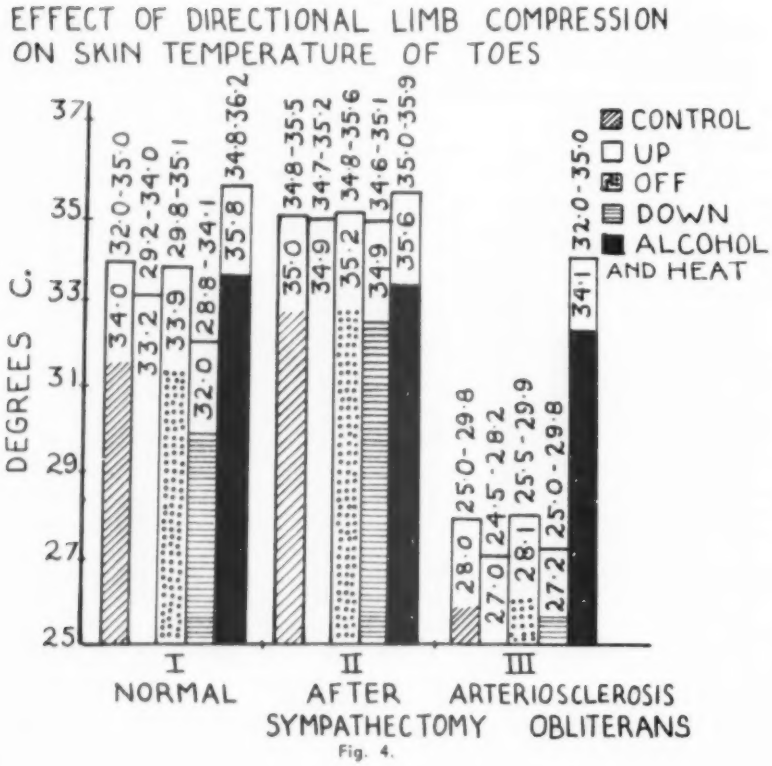
EFFECT OF DIRECTIONAL LIMB COMPRESSION
ON SKIN TEMPERATURE OF TOES
DEGREES C.
CONTROL
UP
OFF
DOWN
ALCOHOL
AND HEAT
I
NORMAL
II
AFTER
SYMPATHECTOMY
III
ARTERIOSCLEROSIS
OBLITERANS

Fig. 4.

B.—The effect of directional limb compression on skin temperatures of the toes was carried out in subjects of groups I, II and III (fig. 3). In all groups the skin temperature was decreased by directional limb compession, whether the direction was up or down. Likewise, in all groups, alcohol and heat increased the skin temperatures over the resting values. Only minimal variations in the skin temperatures occurred in sympathectomized patients (group II), whereas a significantly greater change (fall in skin temperatures) occurred in groups I and III. Of particular interest is the striking increase in skin temperature which occurred after alcohol and heat in patients of group II. This demonstrates the susceptibility of these patients to a strong vasodilating stimulus.

C.—Effect of directional limb compression on the pulsations of the toes was studied in groups I, II and III (fig. 4). In groups I and III, directional limb compression decreased the height of the pulsation of the wave whether the compression was up or down. Small variations in the height of the pulse waves of the toes were seen in the sympathectomized patients of group II. Alcohol and heat increased the volume of the pulsation, especially in normal subjects (group I) and unsympathectomized patients (group III), whereas only slight increases in the height of the pulse wave were seen in patients of group II.

D.—The effect of directional limb compression on venous pressure and total volume of the toes was studied in eight subjects of group I (figs. 5 and 6). The venous pressure was measured in the internal malleolar vein continuously during the operation of the directional limb compression. An average increase in venous pressure of 6.0 mm. of mercury over the resting level occurred with each upward inflation of the cuffs (fig. 5). More than twice this pressure was reached when the cuff was inflated in the downward direction. These changes in pressure were reflected in the total volume of the digit with each inflation (fig. 6). When the cuffs were inflated upward, the volume of the toe increased on the average by 6.0 cu. mm. When downward, it increased 11.0 cu. mm.

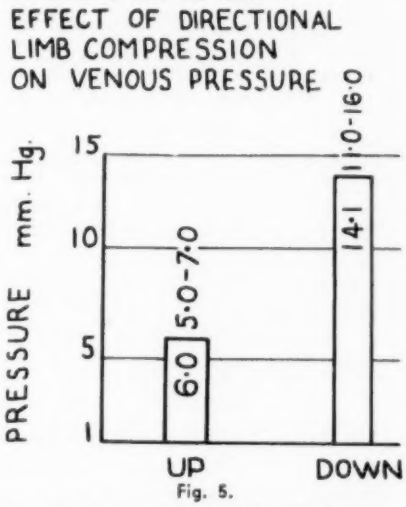

Fig. 5.

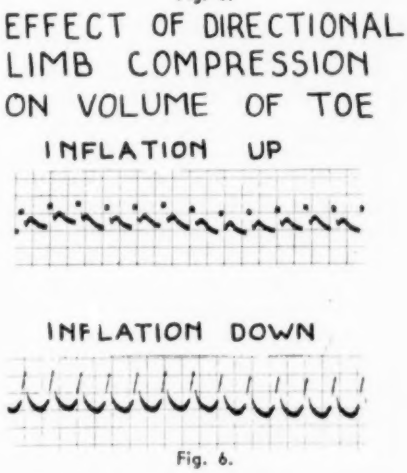

Fig. 6.

E.—Effect of directional venous occlusion on tissue pressure, skin distensibility and lymphatic flow: Two patients with edema (one of the leg, the other of the arm) and one normal subject were studied. Tissue pressures were recorded before and after treatment; the cuffs (applied to the arm in one case and to the leg in the other) were inflated toward the heart. Before treatment, the edematous limbs were distended, tense and swollen with a nonpitting edema. The tissue pressure in the leg was 30.0 and in the arm 28.0 mm. of water. After 30 minutes of treatment these values

were 20.0 and 18.0 mm., respectively. Lymphatic flow before treatment was 18 and 20 mm./sec., respectively, and after treatment 20 and 60 mm./sec., respectively. Skin distensibility was increased 20 per cent in the patient with edema of the leg and 23 per cent in the patient with edema of the arm. A consistent decrease in limb circumference of more than three centimeters was seen immediately after treatment in both patients. While in these two patients with edema lymphatic flow was improved by directional compression, dye tests on a normal subject showed no significant change in lymphatic flow.

Discussion

These studies are in accord with those of others[5,9,10,11,14] who were unable to demonstrate an increase in blood flow after intermittent venous occlusion. It is probable that the development of reactive hyperemia requires a period of occlusion of arteries[10] and venous occlusion for short periods of time is ineffective in bringing about this reaction. Our results also confirm the observations of Terrier et al[19], who found that venous occlusion for five minutes with a pressure of 40 mm. of mercury in normal and arteriosclerotic subjects resulted often in a decrease in blood flow.

Directional limb compression, like intermittent venous occlusion, was not effective in increasing the skin temperature, the pulse volume or the blood flow of the toe, regardless of the direction of compression, even though these patients showed considerable vasodilatation following alcohol and heat. In general, the sympathectomized patients did not show as large a decrease in the peripheral circulation as did the unsympathectomized group. From this observation one may speculate that direct compression of the tissues stimulates the sympathetic vasoconstrictor fibers which decreases the circulation to the toes. During directional limb compression with each wave of compression, regardless of direction, there is increased venous pressure, increased total volume and volume pulsation of the toe, accompanied by decreased skin temperatures. Immediately following the onset of directional compression and for five minutes after cessation, decreases in skin temperatures, blood flow and volume pulsation were seen. From these findings, one would conclude that any change in volume of the digit during directional compression is due to an increase of venous blood rather than to an increase in arterial circulation. These studies therefore do not support the concept of increased arterial flow as a result of intermittent or directional limb compression.

In two patients lymphedema was decreased, as evidenced by a decrease in limb circumference and tissue pressure and an increase in skin distensibility. Such changes were observed after 30 minutes of treatment with the direction of compression upward. This beneficial action on lymphedema may have occurred locally by means of the increased external pressure on the tissues and stripping of the lymphatic vessels of their contents without producing general changes in lymph circulation. Further studies are indicated to determine whether lymph flow is influenced generally or locally.

A massaging action undoubtedly exists with directional limb compression, but the effects of massage, as indicated by reports of various workers, are inconclusive as to their effects on circulation. Wakim and his associates[20] state that there is no consistent increase in total blood flow after deep stroking and kneading massage of the extremities in normal subjects, but that there is a moderate, consistent and definite increase in circulation after deep stroking and kneading massage of the extremities of subjects having flaccid paralysis. Studies made by Drinker and Field[21] and by Drinker and Yoffey[22] on lymphatic flow, have shown that upon initiation of massage there is a rapid flow of lymph, which decreases in rate over a ten minute period and ceases almost immediately when the massage is discontinued. From these studies, one may assume that massage does not have a significant effect on blood flow but may improve temporarily the flow

of lymph. Ladd, Kottke and Blanchard[23], however, recently have studied the effect of massage on tissue fluid movement and lymph production in dogs. They report that massage of the forelimb is significandy more effective in producing lymph flow than either passive motion or electric stimulation.

Summary

From the foregoing observations under the conditions of our study neither intermittent venous occlusion nor directional limb compression had any significant beneficial effect on the arterial circulation of the lower extremities. However, directional limb compression reduced lymphedema significantly in two instances.

The authors express their gratitude to Mrs. Grayce Fleming for her technical assistance in this work.

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Mineral Springs In The Commonwealth Of Pennsylvania: A Field Survey*

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Recent revival of interest in balneology, a recognized branch of Physical Medicine, stimulated us to undertake this survey. It is clearly the responsibility of those interested in Physical Medicine to place balneology in this country on a rational and scientific footing. To accomplish this involves comprehensive studies which fall into three groups: (A) preparatory field work including location of mineral springs, complete on-the-spot survey, collection of water samples, determination of water temperature and rate of flow, and the assembly of the medico-historical data and of photographic records; (B) complete physical, chemical and bacteriological examination of waters, the appropriate classification of springs and determination of their physiological and therapeutic potentialities, and (C) evaluation of mineral water on the basis of experimental laboratory studies and controlled clinical investigations.

To attempt such a comprehensive analysis of the sources of mineral waters in this country as a whole presents insuperable difficulties, especially since no recent figures are available on mineral springs in the United States. In 1886, Stearns[1] counted 8,843 springs in 2,822 localities, which included 634 spas and 223 sources of commercial mineral water. The problem can be approached satisfactorily only by arousing the interest of local groups in investigating the water sources available in their own areas.

Consistent with such a policy it was decided to examine the sources of mineral water in our own State of Pennsylvania, which, owing to its favorable geological formation, is richly endowed in natural wealth. The plan adopted was to obtain all available information regarding the past and present uses of such sources and to chart their location and distribution. Despite the splendid cooperation demonstrated by the local populations and the several authorities, this study had to be limited largely to a field survey based upon local findings. Even that proved a costly and time consuming undertaking. Because of their cost, complete laboratory tests had to be omitted. Old water analyses obtained at times from owners of the springs or the records of present examinations of bottled water by the State had to be used in the preparation of a simple classification. Unfortunately, these examinations are mainly concerned with the sanitary condition of the springs rather than their mineral content.

The plan to survey mineral springs in the Commonwealth of Pennsylvania, conceived before 1940, was interrupted by World War II. The project lay dormant until its reactivation in 1950. The cooperation of the State Department of Health was secured and has proved extremely helpful. All district engineers in charge of water supply in the entire State made available their experience and cartographic material; they frequently assisted this survey personally or through their associates or other trained personnel. Without their help and advice search for the springs would have required many more months and in many instances would have been futile.

About one half of the springs and wells sought were located easily. The location of the remainder proved tedious

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but engrossing. It involved interviewing scores of people including physicians, librarians, local historians, postal clerks, members of the State police and many other residents. The end result was gratifying, as all old springs and a number of previously unlisted ones were found; interesting historical material was obtained; old pictures of the spas were collected; many hundreds of photographs were taken and the location of the springs charted. This involved several trips during the years 1951 and 1952. The total distance covered was over 5,000 miles, excluding the mileage of advance trips by the engineers in several districts.

This field survey was based on data obtained from many sources including medical literature, county histories and some old newspapers. Many bibliographic statements were vague as to the location of springs. Changed names greatly complicated the task of identification. The works of Bell[2], Crook[3], Solly[4], Yeo[5] and Bierman[6] furnished interesting data as to contemporary attitudes towards climato- and balneotherapy on the North American continent. The first medical publication on mineral springs in the colonies must be credited to Benjamin Rush[7], versatile physician, scientist, writer and politician. Rush knew of five mineral springs in and around Philadelphia; Bell[8] initially listed twenty-one in the United States and a few years later[9] increased this number to 181, with 13 springs in Pennsylvania. In the same year (1885), the less agile or more critical New Yorker, Disturnell[10], reduced the latter figure to four. Moorman[11] listed 171 mineral springs in the whole country and Bell[12] added two more twelve years later. Walton[13] mentioned in 1874 eight mineral springs in Pennsylvania. Bushrod[14] increased this number to twelve while Crook[3] managed to find eighteen.

The American Medical Association showed an interest in this field as early as 1880. A committee composed of William Pepper, H. I. Bowditch, A. N. Bell, S. E. Chaille and Charles Dennison, was appointed to investigate existing facilities for spa therapy. They reported five hundred such localities in the United States. Peale (1886), [15, 16] contributed valuable data on the location and characteristics of mineral springs in this country. This author recorded sixteen springs located in Pennsylvania. The most comprehensive medical work on the subject of balneology in the United States is the more recent (1927) compilation by Fitch[17]. He noted forty-six sources of mineral water in Pennsylvania. Stearns and his co-workers[18] found only one thermal (tepid) spring in that State. In the last two decades much information has been added to our all too meager knowledge of American balneology by Kovacs, Singer and especially by the present leader in this field, McClellan, and his associates.

During the 180 years that have elapsed since the first medical publication on Pennsylvania's spas, profound changes have taken place. Hamlets have become large towns, factories have supplanted scattered farms, even the landscape has so changed that landmarks have been destroyed. Many medicinal springs which lost their attraction have been abandoned. As once flourishing health resorts deteriorated no new ones were developed to replace them. Many spas in Pennsylvania were situated too far from large, populous centers. New railroad lines and highways by-passed them. Even popularization of the automobile has failed to help this situation. A few resorts in the vicinity of railroad stations or on main roads have survived this ordeal and apparently are now recovering from their economic depression.

While tracing the presence and location of presently known mineral springs, the original plan was widened to include a search for the vanished watering places. The results were illuminating. Of twenty-nine recorded spas, only three were still existent. Seven former mineral spring hotels now serve other purposes; one was converted to a resort hotel without any therapeutic facilities; eighteen others have vanished permanently. The historical data on the spas of Pennsylvania will be published

in two separate papers[19, 20].

In Pennsylvania, as elsewhere throughout this country, the decline of interest in balneotherapy has been a handicap to the chronically ill, the convalescents, and the steadily increasing old age groups. In the last century Pennsylvania boasted of a number of prosperous health resorts and spas with facilities ranging from simple inn-like accommodations to luxuriously appointed hotels. Unfortunately, decreasing popularity and lack of medical interest has diverted the public from those establishments and precipitated their ruin. This is the more remarkable because the acknowledged medicinal properties of a number of mineral waters in Pennsylvania entitles them to serious consideration. In accordance with their contents and the degree of mineralization, these waters have been frequently used to advantage in the management of selected gastro-intestinal and biliary tract ailments, for arthritis and allied rheumatic conditions and in diseases of the urinary tract.

Although the medical profession is hardly responsible for the vaccilating sentiments of the public, its attitude in no small degree accounts for the decline of balneotherapy in Pennsylvania. The lack of enthusiasm on the part of the average physician to such therapy was deplored by O'Neal[21] some seventy years ago. In his inaugural address as president of the Adams County Medical Society, O'Neal stressed the fact that his confreres never attempted to assimilate knowledge of the use of natural mineral water for the benefit of their patients. O'Neal's eloquent reproach fell on deaf ears and did not stay the impending decline of Pennsylvania's spas. About half a century later, a committee appointed by the American Congress of Physical Therapy undertook the difficult task of analyzing the causes of the decay of American spas. Sigerist[22, 23] also has pointed to many circumstances which have been in part responsible for this deplorable situation.

In the conduct of this survey no attempt was made to eliminate the waters of low mineralization (i.e. those with less than 1 gm. of minerals per liter of water), as the degree of the latter is not always a reliable criterion of its effectiveness. Practically all the waters are hypothermal but of higher temperature than the mean annual temperature in their localities. Stearns et al[18] mention one thermal spring of 72 F. (22.2 C.), Perry Warm Spring. Determination of temperature in the small artificial basin in front of this spring revealed only 19 C. The partly obstructed flow of the neglected spring and thus prolonged exposure to the air may have been responsible for the lower reading.

In the course of this survey a total of 51 water sources were visited. These have been roughly divided according to their contents. Four springs were eliminated as of no medicinal significance.

Table 1 gives the location of all noncommercial springs and wells which contain less than one gm. of minerals in one liter of water. All springs not analyzed but used for medical purposes in the past are listed here also. This table lists the location of 23 springs and 2 wells. Six localities have more than one mineral spring; thirteen were in good, six in satisfactory, and six others in poor condition, at the time of this survey. Present medicinal use is limited to four localities with ten springs, ten other springs supply table water, eleven springs are no longer used. The waters of nineteen springs were used in the past for medicinal purposes while in six other places the therapeutic past could not be ascertained.

Table 2 shows all springs and wells which contain one gm. or more minerals in one liter of water. It lists six localities with ten individual springs and one well. Only three springs now used are in good condition. Pennsylvania has a number of commercially exploited springs and wells, some of very low mineralization. Many claims were made in the past of their therapeutic value and sixteen springs found their way into medical literature. These waters are at present sold as table water or used in the manufacture of soft drinks. The listing of these springs was omitted here.

TABLE 1*

No.	Name of Spring or Well	P.O. or Location	COUNTY	Number and Present Condition			Water Used Presently	Past Med. Use
1	Black Barren	Pleasant Grove	Lancaster	S		s	+	?
2	Caledonia Springs	State Forest	Adams	S		s	O	=
3	Cambridge Springs	Cambridge Springs	Crawford	S	3	g	+	=
4	Doubling Gap Springs	Doubling Gap	Cumberland	S	3	s	+	=
5	Fayette Spring	Chalk Hill	Fayette	S		p	O	=
6	Frankfort Springs	Hookstown	Beaver	S	2	g	O	=
7	Huntingdon Mineral Spring	Huntingdon	Huntingdon	S		p	O	=
8	Katalysine Spring	Gettysburg	Adams	S		g	O	=
9	Kiskiminetas Springs	Saltsburg	Indiana	S	2	p	O	=
10	Minnequa Springs	Canton	Bradford	S		g	O	=
11	Mt. Holly Springs	Mt. Holly	Cumberland	S		g	+	=
12	Pavillon Spring	Grand View Sanator.	Berks	S		g	+	=
13	Perry Warm Spring	near Alinda	Perry	S		s	+	=
14	Pleasant Gap	Pleasant Gap	Center	S		g	+	O
15	Ponce de Leon	Meadville	Crawford	S		g	+	?
16	Sizerville Spring	Sizerville	Cameron	W		g	+	=
17	Sulphur Springs	Carlisle Springs	Cumberland	S		p	O	=
18	Sulphur Spring	Loganton	Clinton	S		g	+	=
19	Sulphur Spring	Monarch Park — Franklin	Venango Co.	S		g	+	O
20	Sulphur Well	Weltytown	Westmoreland	W		g	O	O
21	Tuckhoe Mineral Springs	Tuckhoe Mineral Springs	Northumberland	S	3	p	+	=
22	White Star Spring	Sands Eddy	Northampton	S		s	+	O
23	White Sulphur Spring	Mann's Choice	Bedford	S		g	+	=
24	Yellow Springs	Chester Springs	Chester	S	3	s	O	=
25	York Sulphur Springs	York Springs	Adams	S		p	O	=

*Key to Tables 1, 2 and 3: S spring, W well, number after S or W denotes the number of water sources; condition: p poor, s satisfactory, g good, ? questionable; + used, O not used, = used for therapeutic purposes in the past; an analysis available; spring: existing, o not existing; hotels: D destroyed, E existing but not used, A active.

Past and present spas are listed in Table 3.

Up to the present, this survey has located twenty-nine spas with hotel accommodations which existed in Pennsylvania at different periods during the last 200 years. Only three spas are active. The rest were destroyed or abandoned. One spring could not be identified with certainty, four springs dried up and twenty-four are still producing.

The value of field work is well illustrated by the discovery of Radon (RADium emanatiON) in a spring in Philadelphia. (Radon (Rn) is a gas soluble in water, air and in oil.) It has the atomic number 86, the atomic weight 222, a half-life of 3.825 days and emits, according to Bladergroen[26], alpha radiation. Bohn and Nadig,[28] who examined hundreds of springs for radioactivity in the United States, found that this spring in Wissahickon, situated only a few miles to the Northwest of the center of the city, but still within city limits, contains Radon. Repeated determinations showed, as expected, moderate fluctuations. The results of this investigation were presented by Bohn at the meeting of the American Physical Society in New York. The water of the Wissahickon spring contains 240×10^{-10} c/l or 65.93 Mache Units (M.U.) of Radon. This figure makes the "Bohn Spring" at Wissahickon one of the strongest in this country. It compares favorably with similar springs on the Continent.

A partial chemical analysis made by the State Laboratory in December, 1951 and January, 1952[29] revealed an alkalinity of 26, pH of 6.1, total solids 300, hardness 160, Chloride 49, Sulfate 94, Aluminum 0.3, Calcium 30, and Magnesium 21, Fluoride 0, Chromium 0, Copper 0, Iron 0, Manganese 0, Barium 0, expressed in parts per million.

The therapeutic effectiveness of Radon in very small amounts still may be open to discussion. An overdosage might cause unpleasant reactions and force an interruption of treatments. The physiologic action of Radon is not well understood. Water containing Rn is used mainly for baths and inhalations, drinking seems to be of lesser importance. The alleged satisfactory results achieved with Rn in many domestic and foreign spas are the only evidence of its therapeutic value, based entirely on empirical observations. In the light of recent experience there is a tendency to lower the previously established therapeutic requirements of Radon in water. Kolb[27] states that the following standards of Rn are being considered internationally: Rn of 13.73 M.U. (50.0×10^{-10} c/1) for average radioactive and 54.92 M.U. (200.0×10^{-10} c/1) for very strong radioactive waters.

No specified therapeutic norms of naturally radioactive waters are, at present, available in this counutry. According to Vogt and Amelung[28] some South American and European countries adhere to the following scheme:

TABLE 4.

Country	x10^{-10} (adapted) curie/liter	Mache Units
Argentina	10.92	3
Austria	from 50.0 to 200.0	13.73 to 54.92
Ecuador	10.92	3
France	100.0	27.47
Italy	12.74	3.5
Switzerland	18.2	5

By comparison with the above listed standards, the Philadelphia Radon Spring belongs to the group of strongly radioactive, cold springs. Determination of Rn in domestic sources is still not completed. Table 5 lists the Rn contents of springs of known spas in the United States both in curies per liter and Mache Units.

TABLE 5.

Arrowhead Hot Springs, California (29):						
Spring:	Penyugal	2.2×10^{-10}	c/1	or	0.61	M.U.
	Granite	2.0	"	"	0.55	"
	Palm	3.7	"	"	1.01	"
Harlem Hot Springs, California:		18.0	"	"	4.94	"
Hot Springs, Arkansas (30):						
Spring:	Imperial	90.5	"	"	24.86	"
	Twin, North	22.2	"	"	6.1	"
Manitou, Colorado:						
Spring:	Shoshone	47.3	"	"	13.0	"
	Lester's No. 150	273.0	"	"	75.0	"
	Lester's No. 207	305.5	"	"	84.0	"

Conclusions

This field survey is the most recent attempt to locate and inspect sources of mineral water in the Commonwealth of Pennsylvania. Only places of alleged therapeutic significance were considered.

TABLE 2*

No.	Name of Spring or Well	P.O. or Location	County	Number and Present Condition			Water Used Presently	Past Med. Use
1	Bedford Springs	Bedford	Bedford	S	3	g	+	= An.
2	Cresson Springs	Cresson	Cambria	S	3	p	O	= An.
3	Gaylord Springs	Blossburg	Tioga	S	2	p	O	= An.
4	Parker Mineral Springs	Gardeau	McKean	S		p	O	= An.
5	Pulaski Springs	Pulaski	Lawrence	W		?	O	= An.
6	Three Springs	Three Springs	Huntingdon	S		g	+	= An.

TABLE 3*

No.	Name of Spring or Well	P. O. or Location	County	Mineral Springs	Hotels	Active
1	Bedford Springs	Bedford Springs	Bedford		A	Yes
2	Blossburg (Gaylord Spring)	Blossburg	Tioga		(Bath) D	No
3	Bristol Bath	Bristol	Bucks	o	D	No
4	Caledonia (Sweeney's Cold) Springs	Caledonia State Forest	Adams		D	No
5	Cambridge Springs	Cambridge Springs	Crawford		A	Yes
6	Carlisle Springs	Carlisle Springs	Cumberland		D	No
7	Chester (Yellow) Springs	Chester (Yellow) Springs	Chester		E	No
8	Cresson Springs	Cresson	Cambria		D	No
9	Doubling Gap Springs	Doubling Gap	Cumberland		E	No
10	Ephrata Mountain Hotel	Ephrata	Lancaster		E	No
11	Fayette Springs	Chalk Hill	Fayette		D	No
12	Frankfort Mineral Springs	Frankfort Springs	Beaver		D	No
13	Gettysburg Katalysine Spring	Gettysburg	Adams		D	No
14	Graeffenburg Inn	Fayettville	Adams & Franklin	o	A	Yes
15	Grand View Sanatorium	Wernersville	Berks		E	No
16	Huntingdon Springs	Huntingdon	Huntingdon		D	No
17	Kiskiminetas Springs	Saltsburg	Indiana		E	No
18	Loganhouse	Loganton	Clinton		D	No
19	Minnequa Springs	Canton	Bradford		D	No
20	Mt. Holly Springs	Mt. Holly Springs	Cumberland		E	No
21	Parker Mineral Springs	Gardeau	McKean		D	No
22	Perry Warm Springs	Alinda	Perry		E	No
23	Pulaski Springs	Pulaski	Lawrence	o	D	No
24	Saegerstown Mineral Springs	Saegerstown	Crawford	o	D	No
25	Sizerville Springs	Sizerville	Cameron		D	No
26	Three Springs	Three Springs	Huntingdon	?	D	No
27	Tuckhoe Mineral Springs	Northumberland	Northumberland		E	Yes
28	White Sulphur Springs	Mann's Choice	Bedford		A	Yes
29	York Springs	York Springs	Adams		D	No

Various kinds of water, recommended in the past for their medicinal properties, are being bottled now for domestic use. These commercial water sources are not included here.

Pennsylvania had in 1952 three active spas, none of which are approved by the Council on Physical Medicine and Rehabilitation of the American Medical Association.

Good mineral water in sufficient amounts, free of contamination and impurities, is a valuable therapeutic asset. The proper evaluation of water and its source requires the cooperation of various scientific groups with broad tasks assigned to competent public agencies. An appropriately staffed and equipped research institute of balneology and balneotherapy, incorporating also medical climatology and climatotherapy, offers the most promising solution. The resources of any one medical department are hardly sufficient to solve problems with such wide ramifications.

The restorative and rehabilitative possibilities offered in the environment of a modern spa are not met by other existing medical facilities. Strict adherence to established selective indications is, of course, imperative. Balneology offers effective therapeutic approaches to many somatic and psychosomatic problems in medicine.

It is hoped that this field survey may help increase interest in balneology and stimulate similar studies in other parts of our country.

Acknowledgement — The authors acknowledge with deep gratitude the invaluable assistance and friendly collaboration of Dr. Russell E. Teague, Secretary of Health of the Commonwealth of Pennsylvania; Mr. H. E. Moses, Consulting Chief Engineer; Mr. J. R. Hoffert, Chief Engineer; Mr. L. D. Matter, Assistant Chief Engineer, and the District Engineers Messrs. B. S. Bush, E. Edgerley, G. A. Elias, J. R. Harvey, R. W. Kremer, L. K. Scheffer and M. E. Wilt.

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Discussion

Dr. F. A. Hellebrandt (Chicago): Doctors Kornblueh and Piersol are to be congratulated on the scope of their field survey of the mineral springs in Pennsylvania.

The project is important in an historical sense. Spas and health resorts played an interesting role in the political and social life of the Commonwealth in the early days of its settlement. They reached their height at a time in medical history marked by a wave of interest in the curative powers of natural remedies. The waters per se were only a part of an elaborate regimen of hygienic control which included close supervision of diet, rest, exercise and recreational activities. Those who frequented the mineral springs believed in their curative powers and gave themselves to the rigors of the "cure" with a discipline that must have had a great impact, multiplied many-fold because spa therapy was group therapy practiced on a very large scale.

It is virtually impossible to identify the single most important ingredient in the "cure"; almost certainly it is not the mineral waters alone. They were rather, a symbol of a *way of life*, which is as good therapy for innumerable chronic ills today as it was in the late nineteenth century when health resorts were in vogue. In fact that *way of life* is the basis of the modern concept of rehabilitation. We tend to emphasize the technical aspects of specific therapeutic procedures, but we all know the power of the group approach to rehabilitation and the importance of well planned programs of balanced rest, exercise, vocational training, diversional activities and so on. The British early recognized the importance of establishing such centers away from the hospital atmosphere. This was one of the outstanding virtues of the health resorts, since they combined the use of curative waters with simple living in an environment conducive to physical restoration.

The survey is the culmination of twelve years of interest—familiarity with the operation of the European spas—belief in the value of various therapeutic waters—and confidence in their revival to meet twentieth century health needs. The plan is orderly; the scope of the undertaking is large. The first step is to arouse interest in the potentialities of natural resources already identified; next—to harness these in the interests of the sick and disabled.

MEDICAL NEWS

Members are invited to send to this office items of news of general interest, for example, those relating to society activities, new hospitals, education, etc. Programs should be received at least six weeks before the date of meeting.

PERSONALS

Elizabeth Austin, Los Angeles, has recently been appointed Associate Professor of Physical Medicine at the University of Southern California School of Medicine. — **Robert L. Bennett,** Warm Springs, Ga., will participate in the NRA Conference to be held at Miami Beach, Fla.; at the same conference, **Josephine Buchanan,** Washington, D.C., will preside over a departmental meeting.—**Anthony C. Cipollaro,** New York City, is Chairman of the New York Academy of Medicine, Section of Dermatology and Syphilology; Chairman of the New York Dermatological Society, and President of the American Board of Dermatology and Syphilology.—Appearing in the July, 1953, issue of MEDICAL TIMES is the article "Physical Medicine and Rehabilitation in Traumatic Conditions" by **Harold Dinken,** Denver. — "Electromyography: A Diagnostic Adjunct in Neuromuscular Disorders" was the topic selected by **Lewis Cohen,** Detroit, Mich., for presentation at the meetings of the Medical Division, Detroit Regional Office of Veterans Administration; Central Medical Society, and Wayne County Optometric Society.—**S. Malvern Dorinson,** San Francisco, spoke on "Evaluation and Supervision by the Physician" at the Cerebral Palsy Workshop held at Stanford University on August 5; he also participated as a group discussion leader in the Cerebral Palsy Parents' Institute given August 18 by the San Francisco State College.—**F. A. Hellebrandt,** Chicago, spoke on "Basic Concepts and Physiological Foundations of Modern Rehabilitation Medicine" at the Chicago-Law-Science Short Course on Legal Aspects of Medicolegal Litigation and Medicolegal Trial Technique on August 6; Dr. Hellebrandt, with co-sponsors, will present the scientific exhibit titled "Physiological Methods of Expediting Motor Learning and Work Output in the Disabled" at the XIX International Physiological Congress in Montreal, Canada.

Miland E. Knapp, Minneapolis, gave the last in a series of medical lectures sponsored by the Veterans Administration in Billings, Mont. Dr. Knapp's address was "Physical Medicine and Rehabilitation as Applied in General Medicine." — **Frederic J. Kottke,** Minneapolis, was a guest of the Minnesota Chapter, National Association of Claimants' Compensation Attorneys meeting held last May. At this meeting, Dr. Kottke, along with other guests, answered questions concerning medical aspects of injuries which are frequent subjects of litigation. — **Edith Kristeller,** New York City, has been appointed Assistant Chief of the Geriatric Rehabilitation Service at Goldwater Memorial Hospital. — **Frank H. Krusen,** Rochester, Minn., spoke at the central states regional conference of the American Public Welfare Association last April.—**Harold Lefkoe,** Philadelphia, is sponsoring the scientific exhibit "Evaluation of the Lumbar Curve" at the 103rd annual session of The Medical Society of the State of Pennsylvania.—**George M. Piersol,** Philadelphia, will participate in a Geriatrics Symposium sponsored by the Veterans Administration and the Peninsula Academy of Medicine (Virginia) in September; he will discuss the contribution of physical medicine to neurology. — **James W. Rae, Jr.,** Ann Arbor, Mich., has been named chairman of the department of physical medicine and rehabilitation and has been promoted to associate professor at the University of Michigan Medical School.—**Henry P. Webb,** Philadelphia, is serving as alternate delegate of the Philadelphia County members of the 1953 House of Delegates of The Medical Society of the State of Pennsylvania. — **Catherine Corson West,** Minneapolis, was one of the members of the Epsilon Chapter committee of the Alpha Epsilon Iota national medical sorority during the 100th anniversary of the Minnesota State Medical Association.—**Harry T. Zankel,** Cleveland, Ohio, spoke on "Use and Abuse of Physical Medicine in General

Practice" at the third annual program of the Ohio Academy of General Practice.

MULTIPLE SCLEROSIS CLINIC OPENED

A new clinic for diagnosis of a mystery disease which affects from six to eight thousand Minnesota citizens was recently opened at University of Minnesota hospitals. The disease, multiple sclerosis, usually strikes suddenly at any part of the nervous system. Symptoms vary, making it extremely difficult to diagnose.

The clinic, set up as a service rather than a research center, will be under the direction of Dr. Charles Van Buskirk, assistant professor of neurology. In addition to diagnosis, prescription of treatment and periodical check-ups, the center will also try out new treatments and diagnosis methods. It will use all facilities available at University hospitals.

COURSES AT POLIOMYELITIS RESPIRATOR CENTER

Physical therapy procedures in the comprehensive treatment of the cardiorespiratory poliomyelitis patient are considered in relation to the physiologic, psychologic, and sociologic implications in the courses given at Southwestern Poliomyelitis Respirator Center, Jefferson Davis Hospital, Houston, Texas. Courses of four weeks will start on September 28 and October 26, 1953. For additional information write to Laura K. Smith, Supervisor of Education.

KOREA NEEDS DIATHERMY MACHINES

Stating that a Federal Communications Commission ruling has outlawed use in the United States of thousands of short-wave diathermy machines whose frequencies interfere with radio and television programs as well as with police and defense communication channels, Dr. Howard A. Rusk, advises that these machines are needed for treatment of crippled and sick persons in Korea. Most of the machines built before 1947 will have to be scrapped. Dr. Rusk, who is medical adviser to the American-Korean Foundation (303 Lexington Ave., New York 16), which is currently conducting a campaign for five million dollars to provide emergency relief for Korea, states that the foundation has received requests for more than 25 machines.

FELLOWSHIPS TO BE AWARDED

The establishment of two Fellowships for clinical and experimental research has been announced by the Trustees of the Jewish Sanitarium and Hospital for Chronic Diseases. The Fellowships, named in honor of the President of the Hospital, Mr. Isaac Albert, will be awarded during the fall of 1953. Applicants should write to the Hospital Superintendent, Rutland Rd. and E. 49th St., Brooklyn, N.Y.

JOSEPH A. CAPPS PRIZE

The Institute of Medicine of Chicago offers a biennial prize of $600 for the most meritorious investigation in medicine or in the specialties of medicine. The investigation may be also in the fundamental sciences, provided the work has a definite bearing on some medical problem. Competition for 1953 is open to graduates of Chicago medical schools, who completed their internship or one year of laboratory work in 1951 or thereafter. Manuscripts, which must be submitted to the Secretary of the Institute, 86 E. Randolph St., Chicago 1, not later than December 31, become the property of the Institute.

NFIP GRANT MADE

The National Foundation for Infantile Paralysis has made a five year March of Dimes grant of $120,000 to the University of Pennsylvania School of Medicine, where the new rehabilitation center for the aid of the physically handicapped will soon be in operation. The center will be directed by a commission on rehabilitation composed of department heads in the medical school and hospital of the University of Pennsylvania, with Dr. George M. Piersol as chairman. Dr. William Dunbar, associate in medicine, public health, and preventive medicine, has been appointed coordinator of rehabilitation to promote the rehabilitation teaching program in the medical school and to maintain contacts between the university hospital and the outside agencies that will cooperate in the various phases of physical medicine and rehabilitation.

COURSE AT CENTER FOR CONTINUATION STUDY

The University of Minnesota will sponsor a continuation course in Rehabilitation for General Physicians at the Center for Continuation Study October 22-24, 1953. The course will deal with the physician's role in the rehabilitation of various types of patients and will provide information concerning agencies which may provide additional help for his patient. The faculty will be headed by Dr. Donald L. Rose, Professor and Head, Department of Physical Medicine and Rehabilitation, University of Kansas School of Medicine, and the program will be under the direction of Dr. Frederic J. Kottke, Pro-

fessor and Head, Department of Physical Medicine and Rehabilitation, University of Minnesota Medical School. The remainder of the faculty will include members of the clinical and full-time staff of the University of Minnesota Medical School and the Mayo Foundation.

ORTHOPEDIC CONTEST

The New Jersey Orthopaedic Society announces its annual contest for the best original contribution in the field of orthopedic surgery submitted by an intern or resident of a New Jersey hospital. A prize of $100 will be awarded the winner. The project, which may deal with any aspect of orthopedics, must be completed during the internship or residency, or within six months thereafter. Papers should be submitted to the Secretary, Dr. William Kruger, 31 Lincoln Park, Newark, on or before January 15, 1954.

MEDICAL TEXTBOOKS NEEDED

Physicians are invited to send their surplus medical textbooks and medical journals to Korea and Israel for utilization by medical schools and hospitals. Express collect shipments should be made to: Alameda Medical Depot, 2155 Webster St., Alameda, Calif., marked "Kormeded"; prepaid parcel post shipments should be made to: Books for Israel, 115 King St., New York 1, N.Y.

EXAMINATION SCHEDULED

An examination for registration under the North Carolina Physical Therapy Practice Act will be given in Gastonia, N.C., Friday, October 30, 1953. Application forms and further information may be obtained from Maria M. Kennedy, Secretary, The State Examining Committee of Physical Therapists, 123 W. Seventh St., Charlotte, N.C.

INSTITUTE OF GERONTOLOGY

The newly created Iowa Institute of Gerontology will serve as a research station and service center for the pooling of resources and work concerning the problems of Iowans over 65 years of age. The Institute will also collect data in such areas as financial resources, employment, housing, recreation, family life, and religious expression, making such data available to all seeking information on these subjects.

FULBRIGHT AWARDS

U. S. government awards (1954-1955) under the Fulbright Act have been announced for Austria, Belgium and Luxembourg, Denmark, Egypt, Finland, France, Germany, Greece, Iraq, Italy, Japan, the Netherlands, Norway, Pakistan, Sweden, and the United Kingdom and Colonial Dependencies. Application forms for university lecturing and postdoctoral research are obtainable from the Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D.C. Applications must be postmarked no later than October 15, 1953.

REHABILITATION PAMPHLET

Figures showing the vast economies that can be achieved through application of modern methods of rehabilitation are cited in a twenty-five cent pamphlet DOING SOMETHING FOR THE DISABLED published by the Public Affairs Committee, Inc., 22 E. 38th St., New York 16, N.Y.

RESEARCH PROGRAMS FINANCED

The following research programs are being financially supported by the Muscular Dystrophy Associations of America, Inc., as of August 1, 1953: Electromyographic Studies on Muscular Dystrophy, New York Medical College, Dr. Arthur S. Abramson, $1750; Proposed Training Program in Physical Medicine and Rehabilitation of Muscular Dystrophy Patients, Bird S. Coler Hospital, Dr. Jerome S. Tobis, $25,000; Studies on the Metabolic Origin of Carnosine and Anserine and Their Possible Physiological Roles in Muscle, University of Iowa, Dr. Theodore Winnick and Dr. Harry M. Hines, $11,880, and Studies in Physical Therapy as it may be applied to Muscular Dystrophy, VA Hospital, Bronx, N.Y., Dr. Arthur S. Abramson, $28,321.

COMING MEETINGS

American College of Surgeons: Thirty-ninth annual Clinical Congress, The Conrad Hilton Hotel, Chicago, October 5-9, 1953; sectional meeting, London, England, May 17-19, 1954.

American Rheumatism Association: Annual meeting (Ohio and Western Pennsylvania Regional meeting), Mayflower Hotel, Akron, Ohio, November 11, 1953. Speakers scheduled are: Doctors J. J. Bunim, R. H. Freyberg, G. M. Martin, C. McEwen, R. L. Preston, C. Ragan, R. M. Stecher, and J. H. Talbott. Dr. Robert Q. Davis, 1405 Goodyear Blvd., Akron 5, Ohio, is acting Regional Chairman.

American Academy for Cerebral Palsy: Seventh annual meeting, Western Hills Hotel, Fort Worth, Texas, October 30 and 31, 1953. Scientific sessions are open to members of the medical or allied professions. Guests shall be required to pay a registration fee. Dr. Harry E. Barnett, 116 S. Michigan Ave., Chicago 3, Ill., is Secretary.

American Institute of Dental Medicine: Tenth annual meeting, Desert Inn and El Mirador, Palm Springs, Calif., October 25-29, 1953. Miss Marion G. Lewis, 2240 Channing Way, Berkeley 4, Calif., is Executive Secretary.

Kessler Institute for Rehabilitation: Second Fred H. Albee Annual Lecture on Rehabilitation, Kessler Institute, West Orange, N.J., October 8, 1953. Meeting is open to all physicians and those desiring to attend should communicate with Registrar at the Institute, Pleasant Valley Way, West Orange, N.J.

National Association for Music Therapy: Fourth annual meeting, Kellogg Foundation, East Lansing, Mich., October 19-21, 1953. Mr. Roy Underwood, Director of the Division of Fine Arts, Michigan State College, East Lansing, Mich., is local Chairman.

Pennsylvania Academy of Physical Medicine and Rehabilitation: Combined meeting with New Jersey Society of Physical Medicine, Sacred Heart Hospital, Allentown, Pa., October 17, 1953. Dr. J. Murl Johnston, 694 Washington Rd., Pittsburgh 28, Pa., is Secretary.

CORRECTION

In the July, 1953, issue of the ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION, page 451, the paper "Effects of Electrical Stimulation Upon Denervation Atrophy in the Rat" should have listed the following additional co-authors: Frank H. Krusen, M.D.; George P. Sayre, M.D., and Khalil G. Wakim, M.D.

BOOK REVIEWS

The reviews here published have been prepared by competent authorities and do not necessarily represent the opinions of the American Congress of Physical Medicine and Rehabilitation and/or the American Society of Physical Medicine and Rehabilitation.

DIATHERMY: SHORT-WAVE THERAPY, INDUCTOTHERMY, EPITHERMY, LONG-WAVE THERAPY. By *William Beaumont*, M.R.C.S., L.R.C.P., Director of Physical Medicine, Westminster Hospital, London. *Second edition*. Cloth. Price, 21s. Pp. 230, with 114 illustrations. H. K. Lewis & Co., Ltd., 136 Gower St., London, W.C.1, 1951.

The first edition of this book was published in 1939. The present second edition is completely re-written and presents virtually a new book. A physicist, Mr. C. M. Dowse, wrote three chapters on the physical principles of long and short-wave diathermy and on apparatus and measurements. This physical part comprises more than one-third of the book. It is well written and non-mathematical. Micro-wave diathermy is not discussed in the book; the author feels "that more clinical evidence has to be collected before a definite therapeutic value can be assigned to such a circumscribed method of tissue healing." This omission is to be regretted notably from the point of view that long-wave or so-called conventional diathermy, to which a considerable part of the book is devoted, has become practically obsolete. In discussing the physiological principles of the action of diathermy treatments, the author states "that the absorption of high-frequency energy by the human tissues must result in some manifestation of the energy transformation syndrome beside that of heat production." This statement is based upon observations and theories made by various workers in the field fifteen and twenty years ago. Today very few authorities would subscribe to an "athermal" action of diathermy waves. The technic for long-wave, and the different types of short-wave diathermy are discussed. Much of the text relating to clinical application considers methods of applying pad and air-spaced electrodes. The methods of application are well illustrated. The book also includes a rather comprehensive glossary of technical terms.

ESSENTIALS OF PUBLIC HEALTH. By *William P. Shepard,* B.S., M.D., M.A. With collaboration of *Charles Edward Smith,* M.D., D.P.H.; *Rodney Rau Beard,* M.D., M.P.H., and *Leon Benedict Reynolds,* A.B., Sc.D. With foreword by *Ray Lyman Wilbur,* M.D., LL.D., Sc.D., Chancellor, Stanford University, San Francisco. Second edition. Cloth. Price, $6.50. Pp. 581, with illustrations. J. B. Lippincott Company, 227-231 S. Sixth St., Philadelphia 5; Aldine House, 10-13 Bedford St., London, W.C.2; 2083 Guy St., Montreal, 1952.

In the minds of many people of the older generation, the term "public health" is still associated with memories of a smug, at times sadistic, kind of paternalism, based on inadequate facts and prejudiced thinking. To such a reader especially, this book will bring comfort and inspiration, for it marshalls a wonderful array of facts and represents the mature thinking of innumerable contributors to the subject. A magnificent passage which everybody should read is the one (pages 224 to 228) quoting a letter written by Judge M. G. Woodward, when he refused to commit a certain patient to a tuberculosis sanitarium.

Planned as a "condensed handbook for the physician engaged in private practice, for the medical student, and for the members of allied professions," it is divided into eleven sections; public health and the practicing physician, environmental sanitation, communicable disease in general, special problems in the control of such disease, other public health problems, school health services, health education, occupational health, problems of lighting and air conditioning, statistics, and public health nursing. Some sections are under the names of special authors, but all exemplify the matured viewpoint that comes from years of interchanging ideas, collecting figures, and testing methods. The book is well provided with bibliographic references and an index. It is a most encouraging sign of the times.

HANDBOOK OF ORTHOPAEDIC SURGERY. By *Alfred Rives Shands, Jr.,* B.A., M.D., Medical Director of the Alfred I. duPont Institute of the Nemours Foundation, Wilmington, Delaware; Visiting Professor of Orthopaedic Surgery, University of Pennsylvania School of Medicine, Philadelphia, Pa. In Collaboration with *Richard Beverly Raney,* B.A., M.D., Professor of Surgery in Orthopaedic Surgery, University of North Carolina, Chapel Hill, North Carolina; Lecturer in Orthopaedics, Duke University School of Medicine, Durham, North Carolina. Fourth edition. Cloth. Price, $8.00. Pp. 644 with illustrations. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, 1952.

This fourth volume of this handbook is an excellent one. The author states in the preface that the heads of the departments of orthopedic surgery in the medical schools of the United States were consulted to express their opinions relative to previous editions and how the book might be improved for the teaching of medical students. The most important suggestion was that the roentgenograms be reproduced as roentgenograms and not as drawings and this was accomplished. A further suggestion was that more detail be presented including surgical technic, plaster technic and further elaboration of the entities; but this was not done so that the book might be kept in the handbook classification. Several new short sections have been added. Excellent bibliographies are presented at the end of each chapter, bringing the text up to date. Many illustrations and drawings in addition to numerous roentgenograms have been added.

This book is an excellent reference for a quick review of orthopedic subjects and with its bibliographies, recommends good reading for further detail on the subject presented. The book is recommended for libraries of orthopedists, physiatrists and others interested in the subject matter covered in this specialty.

CELLULAR CHANGES WITH AGE. By *Warren Andrew,* Ph.D., M.D., Professor of Anatomy and Chairman of Department, The George Washington University, School of Medicine, Washington, D. C. Leatherette. Price, $2.50. Pp. 74, with illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1952.

Dr. Andrew is exceptionally well qualified to discuss this subject, which is one of increasing importance owing to the rapid growth of geriatric medicine. This excellent monograph is divided into four sections: (1) what we mean by "aging," (2) aging of cells "as such," (3) aging in cells of lower organisms and (4) aging in cells of higher organisms.

The author concludes that there is evidence that the oxidative processes in the senescent organism pass through a cycle. There is a period of decline in metabolism associated with the beginning of senescence. Andrew expresses the belief that "adequate treatment by administration of needed hormones and careful attention to nutrition in this phase will result in a rise of the heat production to a normal level. Retardation of degenerative processes and clinical improvement frequently accompany such a recovery." He also expresses the belief that even after degeneration has begun, "adequate therapy may result in improvement." He points to the "encouraging evidence of the ability of therapeutic effort to alter what seem to be fundamental processes in senescence." And his final comment is that "in the search for a

longer and happier and more productive life for human beings, the study of the normal aging process must eventually illumine the dark caverns of our present ignorance."

This authoritative monograph will be of interest to any physician who is concerned with problems of the aging.

HENRY VIII: A DIFFICULT PATIENT. By *Sir Arthur Salusbury MacNalty*, K.C.B., M.A., M.D. Cloth. Price, 18s. Pp. 202, with portrait. Christopher Johnson Publishers, Ltd., 10-14 Stanhope Mews West, London, S.W. 7 [n.d.].

Sir Arthur MacNalty, who has been chief medical officer at the British Ministry of Health and Board of Education, lecturer in public health at the University of Oxford, and editor-in-chief of the official medical history of the last war, has written an interesting biography of the colorful English king, Henry VIII, emphasizing particularly the effects of his various illnesses upon his behavior. Although Henry VIII came from a family among whom there were many who had tuberculosis, there is no evidence that he ever suffered from this disease. He was of fine physique, a famous athlete, and healthy and robust up to middle life. He made a good recovery from a severe attack of smallpox at the age of 22, was stricken with recurrent attacks of benign tertian malaria beginning at the age of 29, and suffered much from varicose ulcers of the legs after reaching the age of 36. When he was 44 years old, he sustained a most serious accident in a tournament, being unhorsed and unconscious for two hours.

It is Sir Arthur's contention that the combination of attacks of malaria, the great suffering from recurrent varicose ulcers of both legs and the marked personality changes following his serious injury to the head sustained in a tournament, altered him from a benign and kindly ruler into a cruel and tyrannical despot. At all times he was an extremely un-co-operative patient, who was so self-willed that he would not follow the advice of his many physicians. He was always a vigorous trencherman who ate and drank so inordinately that during his latter years he became extremely obese and during the last two years of his life his health deteriorated rapidly. He probably died either of pulmonary embolism "or cardiac infection" from a detachment of a clot in the veins of an ulcerated leg or from chronic nephritis with failing heart and dropsy.

In a review of the life of Henry VIII, there is much to support the view that he did undergo a strange change in personality during the middle portion of his reign which markedly altered his behavior and led him to behead not only two of his queens, Anne Boleyn and Catherine Howard, but also to behead a number of noblemen who he feared might threaten his dynasty. At all times he exhibited enormous qualities of leadership and was one of the more powerful of the English kings.

This book will prove interesting to any physician who likes history and particularly history which emphasizes the medical situations involved.

PHYSICIAN'S HANDBOOK. By *Marcus A. Krupp*, M.D., Assistant Clinical Professor of Medicine, Stanford University School of Medicine, Director, Palo Alto Medical Research Foundation, Palo Alto; *Norman J. Sweet*, M.D., Assistant Professor of Medicine, University of California School of Medicine, San Francisco; *Ernest Jawetz*, Ph.D., M.D., Associate Professor of Bacteriology and Lecturer in Medicine and Pediatrics, University of California School of Medicine, San Francisco; and *Charles D. Armstrong*, M.D., Clinical Instructor in Medicine, Stanford University School of Medicine. Seventh edition. Paper. Price, $2.50. Pp. 380 with illustrations. Lange Medical Publications, University Medical Publishers, Post Office Box 1215, Los Altos, Calif., 1952.

This handbook is a small volume packed with factual data on clinical laboratory procedures and much used clinical information, such as biological therapy, vaccines, common drugs and their dosage. The booklet is designed chiefly for the medical student, but will also be of help to the busy physician. So much has been briefly and concisely fitted into this volume that it has forced the use of rather small type.

DISEASES OF THE NERVOUS SYSTEM IN INFANCY, CHILDHOOD AND ADOLESCENCE. By *Frank R. Ford*, M.D., Associate Professor of Neurology, The Johns Hopkins University, Baltimore. Third edition. Cloth. Price, $18.50. Pp. 1181, with 195 illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill.: Blackwell Scientific Publications, Ltd., 49 Broad St., Oxford, England; Ryerson Press, 299 Queen St., W., Toronto, 2B, 1952.

This text has established an enviable reputation as being first in its field since the primary edition 15 years ago. The method of presentation is of the classical type for an American textbook of neurology. The first chapter is on examination of the nervous system and includes many special methods, notably, in this edition, a description of electrodiagnostic testing and electromyography. The second chapter is concerned with anatomy and physiology. The remaining chapters offer clinical and pathological descriptions of neurological disorders with discussion of treatment and prognosis. Chapter divisions are according to etiology. Appropriate bibliographic material is present including classi-

cal references as well as references to some recent therapeutic advances. Case histories are frequently cited and there are numerous illustrative diagrams and photographs, all excellently reproduced. Psychological disorders are for the most part omitted except when they are a characteristic feature of known organic lesions.

This book is highly recommended for all interested in neurological diseases of infants and children.

ADMINISTRATION AND THE NURSING SERVICES. By *Herman Finer*, D.Sc., Professor of Political Science at University of Chicago, Chicago. Cloth. Price, $4.00. Pp. 333. The Macmillan Company, 60 Fifth Ave., New York 11, 1952.

The author arouses interest in the first paragraph by making one realize that he is in sympathy with the problem of today. He then points out that the answer is "better administration." To advance his point, he presents a study of the nursing service from the administrative viewpoint. This nursing service may be in Public Health or in a hospital, for the principles of administration, he states, are the same in both.

The first section of the book deals with "Administration and Problems of the Nursing Profession." It outlines the problems of administration in nursing services. A few of them are as follows: 1. The part the nurse plays in nursing service; 2. the nature of authority and responsibility, and 3. the need for action in the growing shortage of personnel as well as an analysis of the technique of administration in order to improve morale and contentment among workers.

Sections two and three expound the nature and diversities of administration of nursing services, pointing out existing weaknesses, and emphasizing the profit that could be gained by borrowing many principles from industry and business.

The final section deals with the place of administration in nursing education and the education of the nurse for administrative positions. Teaching the nurse to have an imagination will stimulate her spirit and make her a better nurse. Thus administration and the social sciences must go hand in hand in order to improve and advance modern nursing care. This book is a challenge to any nurse who reads it or hears a discussion of its contents.

THE PRINCIPAL NERVOUS PATHWAYS: NEUROLOGICAL CHARTS AND SCHEMAS WITH EXPLANATORY NOTES. By *Andrew Theodore Rasmussen*, Ph.D., Professor of Neurology, Department of Anatomy, University of Minnesota, Medical School, Minneapolis. Fourth edition. Cloth. Price, $4.50. Pp. 73, with illustrations. The Macmillan Company, 60 Fifth Ave., New York 11, 1952.

This booklet is meant to serve primarily as a visual aid to students of neuroanatomy. It consists of 28 black and white diagrams of known neurological pathways grouped according to function. The illustrations are carefully labeled and accompanied by a page or two of descriptive text. They are valuable teaching aids, and useful charts for quick reference, but could be immeasurably improved by use of contrasting colors.

SYNOPSIS OF PATHOLOGY. By *W. A. D. Anderson*, M.A., M.D., F.A.C.P., Professor of Pathology, Marquette University School of Medicine; Pathologist, St. Joseph's Hospital, Milwaukee, Wisconsin. Third edition. Cloth. Price, $8.00. Pp. 788, with illustrations. The C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, 1952.

The student as well as the practicing physician finds a valuable aid in a synopsis of pathology. This book is brief and compact, and fills the need for keeping up with the numerous changes and advances in our knowledge of disease. The first eleven chapters deal with topics in general pathology, while subsequent chapters cover special pathology as it relates to the systems. The author has added new information concerning disseminated lupus erythematosus, cytological characteristics of malignant cells, nephropathy associated with intestinal disease and with diabetes mellitus and grading of gliomas.

A well selected bibliography includes review articles and recent publications in English in easily available journals about subjects of interest. The many photographs, colored plates and tables effectively supplement the text. The book may be recommended to those engaged in medical studies as a guide for the study of general and special pathology.

EDITORIAL

ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION
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STATUS OF INTERMITTENT VENOUS OCCLUSION

Since Collens and Wilensky[1-3] in 1936 and 1937 reported favorably on the clinical application of intermittent venous occlusion in obliterative peripheral arterial disease, conflicting evidence as to its value has been presented in medical literature. As frequently happens, clinical observation does not coincide with laboratory study, the former being generally favorable and the latter, generally unfavorable.

The work reported by Winsor and Selle[8] appearing in this issue of the *ARCHIVES* is a carefully controlled laboratory study of the effect of intermittent venous occlusion and directional limb compression on normal and arteriosclerotic human subjects. Measurements were made of skin temperature, volume blood flow per minute, total volume of a digit, and in some instances venous pressure, skin distensibility and lymph flow. The effects of intermittent venous occlusion and directional limb compression were compared to those of a 45 minute application of heat to the trunk and to the ingestion of two ounces of whiskey containing about one ounce of alcohol. The authors were unable to demonstrate "any significant beneficial effect on the arterial circulation of the lower extremities" of either intermittent venous occlusion or directional limb compression. This report agrees with other controlled experimental studies cited by the authors in their literature review.

Winsor and Selle[8] do not mention in their bibliography and literature review, the experimental work on dogs reported in 1941 by Linton, et al from the Massachusetts General Hospital. These authors utilized a thermostromuhr method for the accurate measurement of blood flow through the iliac and femoral arteries of the dogs' legs. Venous occlusion was produced by ligatures around large accompanying veins and also by an external pneumatic cuff around the upper part of the dog's thigh. By both methods it was demonstrated that intermittent venous occlusion produced a definite increase in arterial blood flow. In fact, the pneumatic cuff produced a greater effect on blood flow than occlusion of the main vein to the extremity. The increase in arterial flow was proportional to occluding pressure up to the point where the occluding pressure started to impede the arterial flow itself. Thus with

a pressure of 40 mm. of mercury, the flow in the iliac artery increased from 120 cc. to 150 cc. per minute; similarly for a pressure of 60 mm. to 205 cc; for 80 mm. pressure, to 250 cc.; for 100 mm. pressure, to 260 cc., and at 120 mm. pressure, the arterial flow began to decrease.

Linton, et al[4] believed that the factor of reactive hyperemia played a minor role in the beneficial effects produced by intermittent venous occlusion. They felt that the increase in arterial flow during the period of occlusion was the main factor in the therapeutic effect. Therefore they recommended that the period of occlusion be longer than the period of release.

It must be remembered that Linton and his associates were dealing with dogs instead of human subjects. The experimental studies cited by Winsor and Selle[3], on the other hand, were done on human beings. The measurement of blood flow in the human was necessarily indirect, while that in dogs, by means of the thermostromuhr, was direct.

Winsor and Selle[3] have mentioned the favorable clinical reports of Collens and Wilensky[1], Kramer[5], Brown and Arnott[6], and de Takáts[7]. Harpuder and Stein[8] were of the opinion, as the result of their combined experimental and clinical study, that venous hyperemia improved the nutrition of tissues, especially in patients with occlusive arterial disease, but they were unable to demonstrate a reactive hyperemia with pressures below 40 mm. of mercury. They felt that their clinical experience demonstrated the therapeutic value of passive hyperemia in peripheral vascular disease, especially in those cases with ulcerative lesions.

It is difficult to say just where the discrepancy lies between experimental and clinical observations on the response of occlusive peripheral arterial disease to the application of intermittent venous occlusion. One possibility is that repeated frequent employment of the procedure on the same patient may have a more favorable effect than single short experimental applications. Experimental observations such as those of Linton, et al on dogs cannot be applied without qualification to the human patient. Adequate control of clinical work is much more difficult than it is in the laboratory. Although experimental studies, such as the one reported in this issue of the *ARCHIVES*, are well done and are convincing, there still exists an unexplained disagreement between them and the clinical results observed by some capable clinicians.

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PHYSICAL MEDICINE ABSTRACTS

The Role of Physical Medicine in the Management of the Upper Extremity Amputee. Raoul C. Psaki, and Aniello F. Mastellone.

U. S. Armed Forces Med. J. 3:627 (Apr.) 1952.

The rehabilitation of the upper extremity amputee is a five-point program, and each phase in the process is equally important to its ultimate success. The psychologic preparation of the patient is vital to the success of the program and should be the responsibility of all concerned with the management of the patient. The orthopedist evaluates the patient's surgical needs and provides an adequate stump. The physiatrist is concerned primarily with the pre- and postprosthetic training of the amputee. This phase of the program is extremely important, because the amputee must be encouraged to use the prosthesis and obtain the maximal functional benefit from it, particularly in bimanual activities. The loss of an upper extremity produces a change in the patient's center of gravity and may produce defects of postural alinement, contractures, and muscular imbalance which will compromise the optimal functional result. Physical measures designed to prevent and correct these deformities should be instituted as early as possible. When physical therapy is started the patient should be indoctrinated in the importance of postural exercises. The definitive preprosthetic measures are determined by an evaluation of the patient with respect to: (1) postural alinement; (2) joint mobility; (3) muscular strength; (4) the presence of pain, and (5) the condition of the stump.

The treatment program consists of general measures such as mat exercises designed to overcome deconditioning, postural defects, as well as muscular atrophy and weakness; specific measures, such as the judicious use of heat, massage, proper bandaging of the stump; and therapeutic exercise to the involved extremity. Adequate mobility of the proximal segments of the extremity must be assured in order that the greatest functional use of the prosthesis may be obtained. Thus the mobility of the scapulas is of prime importance, particularly in patients who will be fitted with the shoulder-harness type of appliance. The degree of ultimate usefulness of the prosthesis depends on the active mobility of the shoulder girdle.

Multipurpose Brace: A Useful Adjunct in Rehabilitation. William B. Snow.

J.A.M.A. 150:687 (Oct. 18) 1952.

This multipurpose brace consists of two tubular lateral bars, both of which are adjustable in length. The adjustment is simple, speedy, and secure, without any screw attachments or special tools. The upper end of the brace consists of a half ring, padded and leather covered, which can tilt laterally to accommodate the lengthening of either side bar. The lower ends of the side bars fit on a narrow flat metal bar covered with a thin weight-bearing rubber pad. This is placed anterior to the heel of the shoe and can be strapped in place. Padded straps are attached to the side bars to serve as supports for the calf and thigh, as is usual in permanent braces. An ingenious knee pad can be strapped anterior to the patella. The half ring at the thigh can serve as the upper end of the brace if the side bars are adjusted to equal length. If, however, the perpendicular outer bar is adjusted to be longer than the inner bar, the ring can serve as an ischial seat and the brace assumes a weight-bearing function. The versatile usefulness of this brace will be immediately obvious to one concerned with bracing problems, especially when the need for bracing is temporary. It is especially useful in cases where, following administration of corticotropin, cortisone, or curare, it is possible to straighten the lower extremities by force therapy. In hemiplegia, arthritis, and cerebral palsy, it is useful as a sleeping or standing brace. These braces are a valuable adjunct to any physical medicine and rehabilitation clinic or orthopedic gymnasium. Several pairs of these braces in sizes consistent with the physical stature of the patients treated should be available. The braces are obtainable in at least three appropriate sizes. They are designed for utiliza-

tion only on a temporary treatment basis, and in no way replace the usual well-designed and fitted orthopedic braces.

Muscular Relaxation as a Therapeutic Procedure. A. B. Gottlober.

Ann. West. Med. & Surg. 6:575 (Sept.) 1952.

Never in the recorded history of man was there ever a time when the need for relaxation was as urgent as it is today. Yet essential as this practice is to mental and physical health, very few people have a true conception of what it is or how it functions. The usefulness of relaxation as a therapeutic procedure has been demonstrated repeatedly. A great many organic disorders such as those involving the digestive and circulatory systems have shown improvement with this method of treatment when drugs and other medical procedures have failed; and relief from symptoms of neurotic origin has been accelerated when relaxation therapy was given concurrently with psychotherapy. Telling a patient to relax is not enough. He must be taught. He cannot be expected to learn by himself. There is a certain definite procedure to follow in which he must be instructed. He must be shown where his greatest tensions occur, how to recognize them and how to release them. He must be motivated and kept at the task until he reaches his goal. Almost anyone of normal intelligence, regardless of age, can be taught muscular relaxation provided he is willing to cooperate for a sufficient period of time, which varies with the individual. Muscular relaxation has been definitely established as an effective therapeutic procedure in a number of mental and physical disorders, such as muscle pain, indigestion and spastic colon, high blood pressure, nervous disorders, speech disorders and sleep irregularities.

The Conservative Management of Chronic Recurrent Low Back Pain. Charles H. Frantz.

J. Michigan M. Soc. 51:1201 (Sept.) 1952.

Approaching the chronic low back pain problem from a conservative standpoint, it is well to remember that all parts of the body are subject to variations in structure and development. This is particularly true of the lumbosacral joint. There are so many variations at this level that it is sometimes difficult to know what is normal. A patient with severe muscle spasm should be put to bed, latter being firm enough to support the lower trunk and back, and the knees should be flexed. Sedatives and antispasmodics may be given freely. Local heat in the form of lamps, heating pad or moist hot packs aid in relieving pain and spasm. If physical therapy is available, one may hasten recovery from an acute bout of pain and spasm by the addition of massage. As soon as pain has decreased, exercises may be started, and these should be continued even after the patient is ambulant. There is universal interest in low back pain problems today, and the principles of "rest, heat, and immobilization, followed by postural rehabilitation" are the essentials of a conservative regimen. Some of us may be remiss in failing to instruct patients properly in postural precautions and protective habits. The results of surgical procedures in large series of cases fall significantly short of the 100 per cent cure figure. All practitioners of medicine should offer as complete a conservative program as possible and "carefully" evaluate the patient as well as his back before considering him a surgical candidate.

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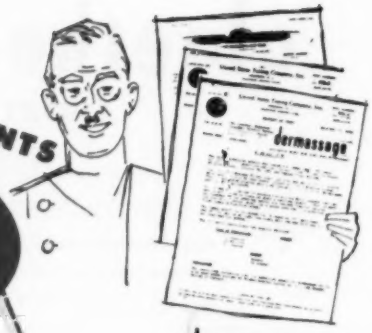

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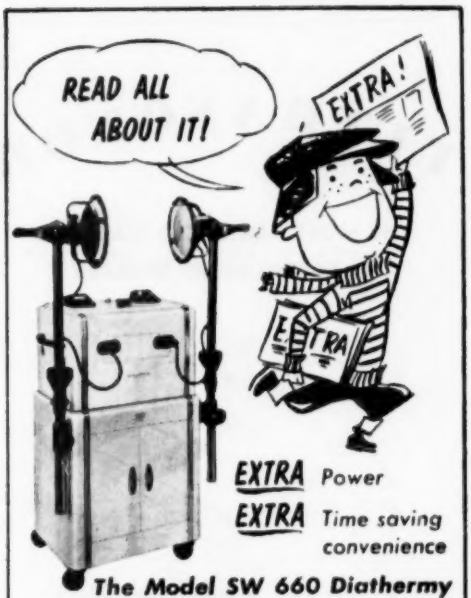

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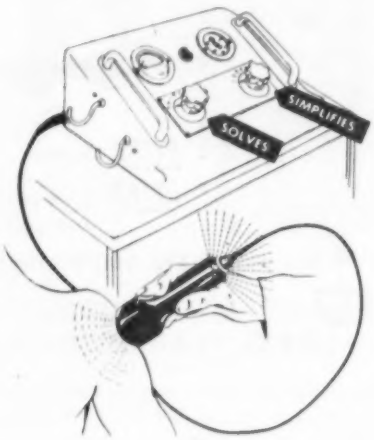

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In this column will be published information about meetings of interest to those in the field of physical medicine. New data should be sent promptly to the office of the ARCHIVES, 30 North Michigan Avenue, Chicago 2, Illinois.

American Congress of Physical Medicine and Rehabilitation — 32nd Annual Session, Hotel Statler, Washington, D.C., September 6-11, 1954. Walter J. Zeiter, M.D., Chairman, Convention Committee, 30 North Michigan Ave., Chicago 2.

Chicago Society of Physical Medicine and Rehabilitation — Regular monthly meetings, September through May, every fourth Wednesday. Joseph Koczur, M.D., Secretary-Treasurer, 55 E. Washington St., Chicago.

Latin-American Congress of Physical Medicine — Scheduled for February 15-28, 1954. Cassius Lopez de Victoria, M.D., Executive Director, 176 E. 71st St., New York 21, N. Y.

New York Society of Physical Medicine — Monthly meetings held first Wednesday. Madge C. L. McGuinness, M.D., Secretary, 48 E. 62nd St., New York 21, N. Y.

Pennsylvania Academy of Physical Medicine and Rehabilitation — Regular meetings on third Thursday of month, held bi-monthly. Secretary, J. Murl Johnston, M.D., 694 Washington Rd., Mt. Lebanon, Pittsburgh, Pa.

American Occupational Therapy Association —Annual Conference, November 13-20, 1953, Shamrock Hotel, Houston, Texas. Marjorie Fish, OTR, Executive Director, 33 West 42nd Street, New York 18, N. Y.

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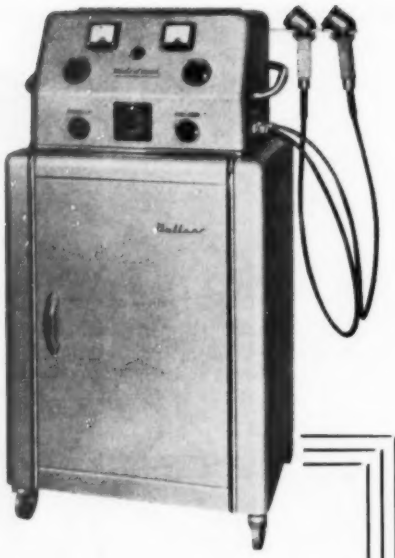

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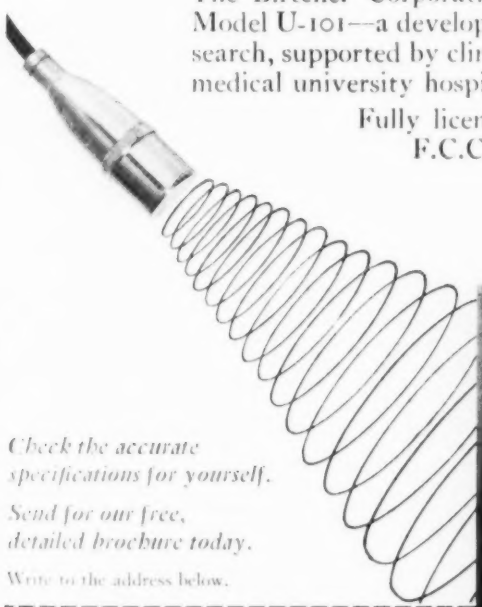

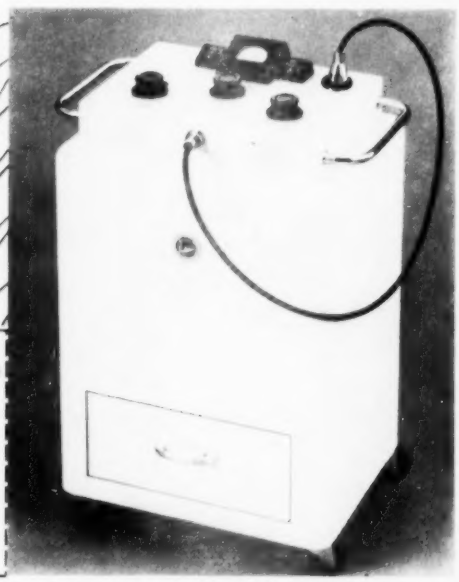

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